INDEX

mercruiser

SERVICE MANUAL

Number 9

MARINE ENGINES

GM V-8 Cylinder

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V-8 Models covered in this manual also MerCruiser versus Sea Ray cross reference.

MerCruiser		Sea Ray	Cubic Inch Displacement Engine Type	Drives Available
1987	1988	1988		
MCM 200	5.0 Litre		305 production	Alpha One
MCM 230	5.0 Litre LX		305 production	Alpha One
MCM230 TR			305 production	TR
MCM 260	5.7 Litre	5.7L	350 production	Alpha One, TR
MCM 260 TR			350 production	TR
MCM 350 Magnum	350 Magnum	SRX 5.7L	350 production	Alpha One
MCM 454 Magnum		SRX 7.4L	454 production	Alpha One
	7.4 Litre		454 production	Bravo One, TR
	454 Magnum	SRX 7.4L-H	454 production performance	Bravo One
MCM 330 B/W			454 production	TR, TRS II SSM
MIE 230	5.0 Litre		305 production	Borg-Warner
MIE 260	5.7 Litre	5.7L	350 production	Borg-Warner
MIE 340	7.4 Litre	7.4L	454 production	Borg-Warner
5.7 Ski	5.7 Litre Comp. Ski		350 production	
MCM 300 Tempest (1986)			350 production performance	TRS, IISSM
MCM 320 EFI	HP 320 EFI		350 production performance	Alpha One SS, Bravo One
MCM 370 TRS			454 production performance	TRS, IISSM
MCM 400 (1986)			454 production performance	TRS, IISSM, IIISSM
MCM 420 (1986)	HP 420		454 production performance	TRS, IISSM, IIISSM
MCM 440 (1986)			454 production performance	IIISSM, IVSSM
MCM 460 (1986)			482 production performance	IIISSM, IV SSM
MCM 575	HP 575		540 production performance	IIISSM, IVSSM

IMPORTANT: Refer to "Engine Identification", page

NOTICE
Refer to appropriate MerCruiser Stern Drive Service Manual for transom assembly and stern drive unit repair.

Service Manual Outline

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D - MCM Models with TR/TRS Drives
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B - Drive Shaft Models/Propeller Shaft
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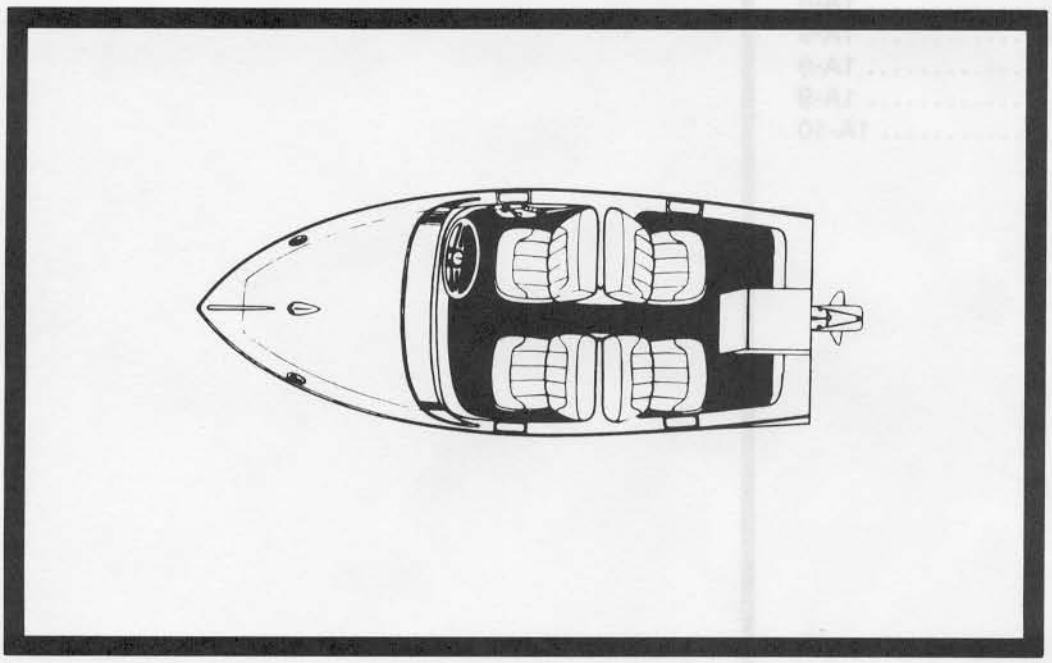
Section 9 - Power Steering

A - Power Steering

COVER

IMPORTANT INFORMATION

1A



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NOTICE

Refer to Appropriate Stern Drive service manual for transom assembly and Stern Drive unit repair.

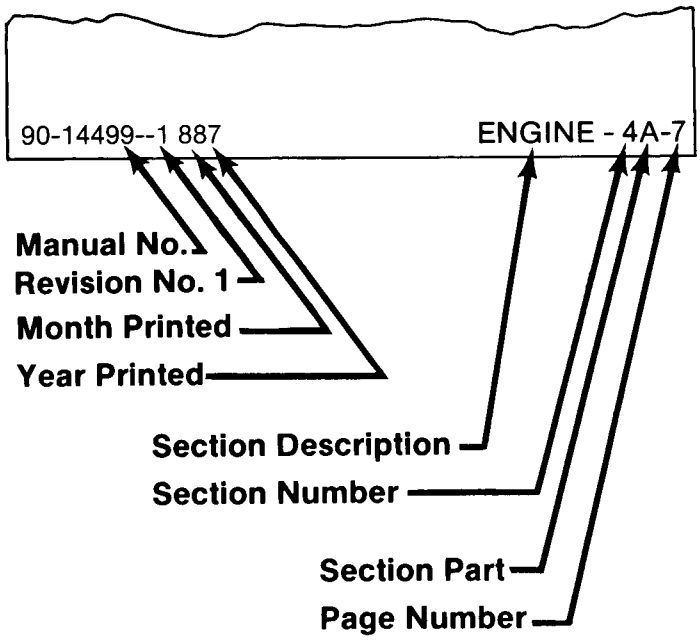
How to Use This Manual

This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts which more fully describe the component.

Page Numbering

Two number groups appear at the bottom of each page. Following is an example and description.



Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the models previously listed. If provides specific information, including procedures for disassembly, inspection, assembly and ajustment. To enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warning required for safety.

Notice To Users Of This Manual

This service manual has been written and published by the service department of Mercury Marine to aid our dealers mechancis and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, of like or similar products manufactured and marketed by Mercury Marine. That they have been trained in the recommended servicing procedures of these products which includes the use of mechanics common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product's safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at time of publication.

It should be kept in mind, while working on the product, that the electrical system and ignition system is capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note that, during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. Numbers on the heads of the metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

Notice

Throughout this publication, "Dangers", "Warnings" and "Cautions" are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. —— Observe them carefully!

These "Safety Alerts" alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus "common sense" operation, are major accident prevention measures.

⚠DANGER
DANGER — Immediate hazards which WILL result in severe personal injury or death.

⚠WARNING
WARNING — Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠CAUTION
CAUTION — Hazards or unsafe practices which could result in minor personal injury of product or property damage.

Replacement Parts

⚠WARNING
Electrical, ignition and fuel system components on MerCrusier Engines and Stern drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Engine Mechanical Components

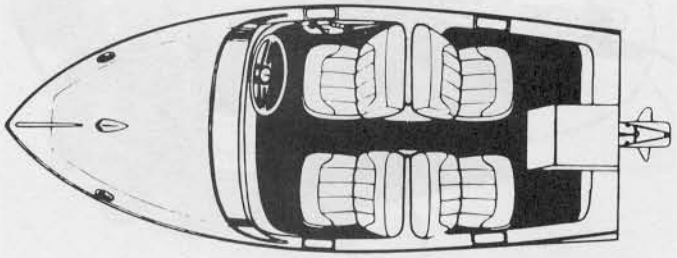
Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement will void the warranty on those parts which are damaged as a result of the use of other than recommended parts.

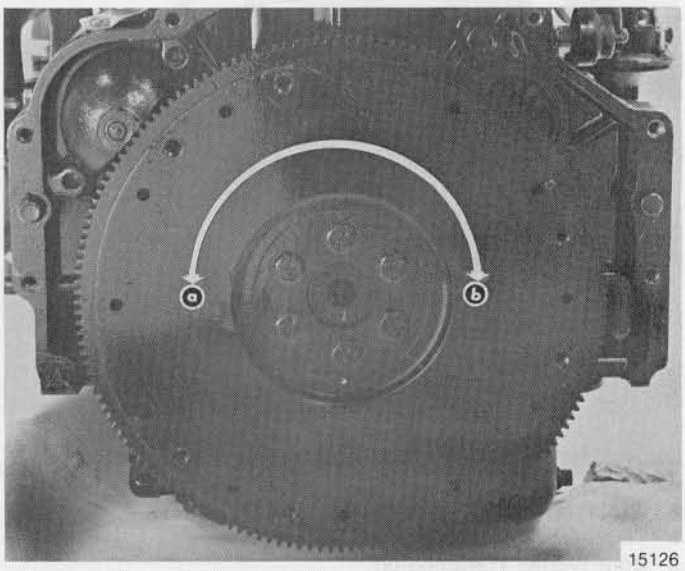
Directional References

Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this maintenance manual, all directional references are given as they appear when viewing boat from stern, looking toward bow.



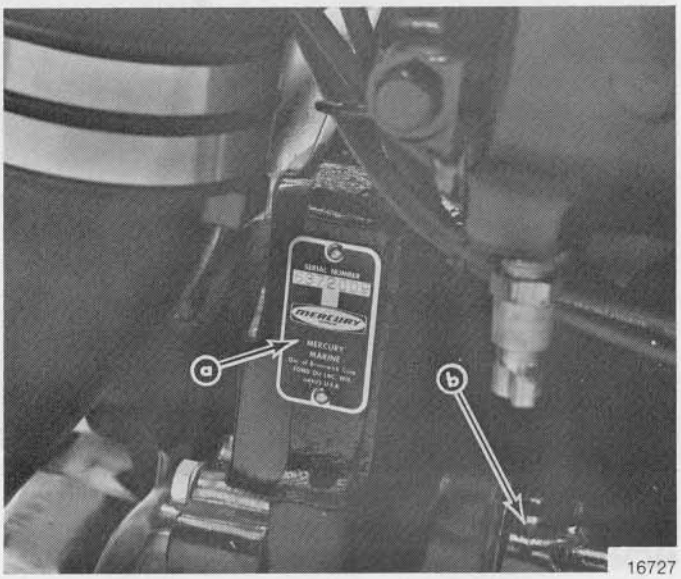
Engine Rotation

Engine rotation is determined by observing flywheel rotation from the rear (stern end) of the engine looking forward (water pump end). Propeller rotation is not necessarily the same as engine rotation. When ordering replacement engine, short blocks or parts for engine, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



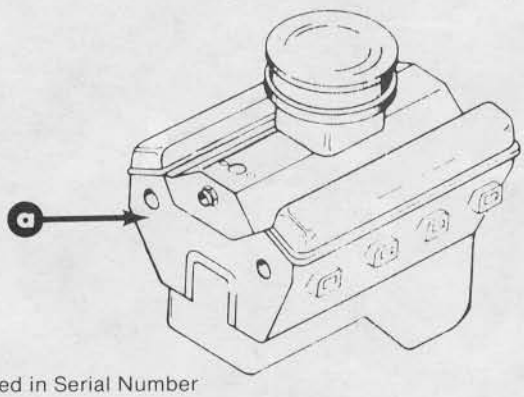
a - Standard Left Hand Rotation - All MCM Stern Drive Engines; MIE Inboard L.H. Rotation Engines
b - Opposite Right Hand Rotation - MIE Inboard R.H. Rotation Engines

V-8 Engine Serial Number Locations



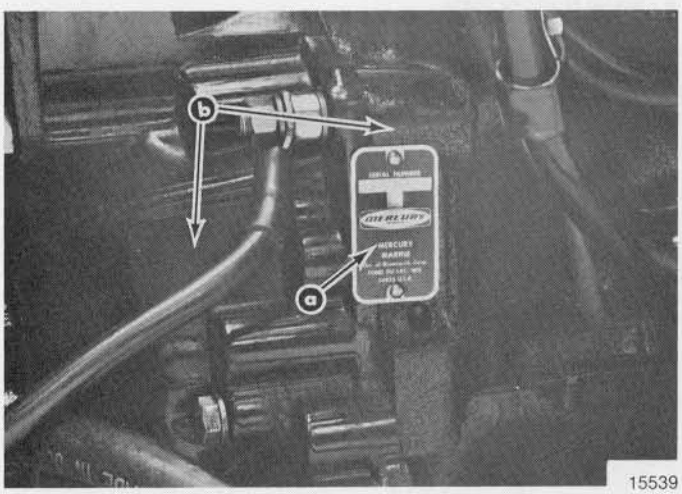
a - Serial Number Plate
b - Starter Motor

MCM 200/230/260/350 Magnum/454 Magnum/ 320 EFI/5.0 Litre/5.0 Litre LX/5.7 Litre/7.4 Litre



a - Stamped in Serial Number

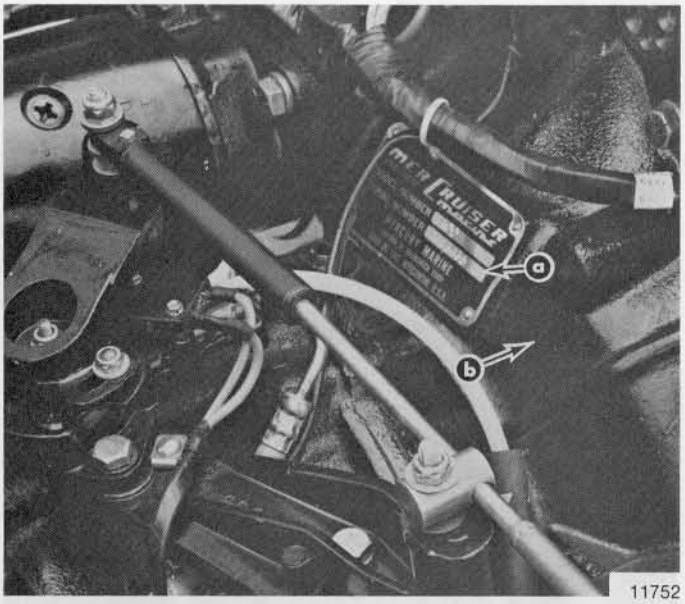
MCM 300 Tempest Alpha One/TRS



a - Serial Number Plate
b - Starboard Side fo Flywheel Bell Housing and Cylinder Block

MCM 330 B/W/370 TRS (S.N. 6721528 and Above)
MCM 420/MCM 575

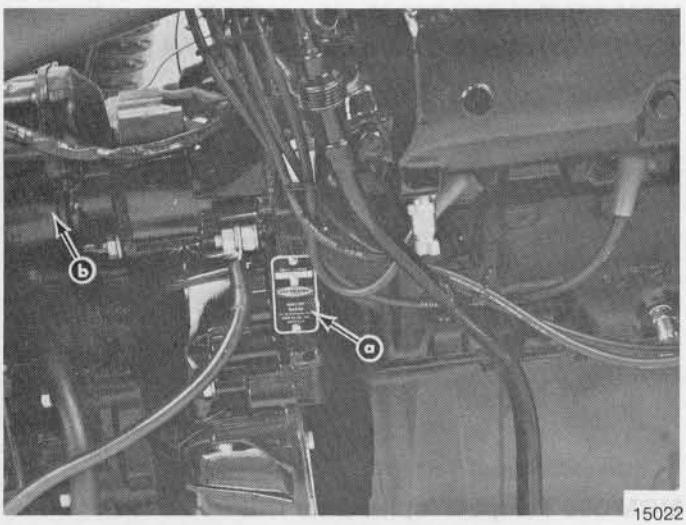
Engine Identification



11752

a - Serial Number Plate
b - Flywheel Bell Housing

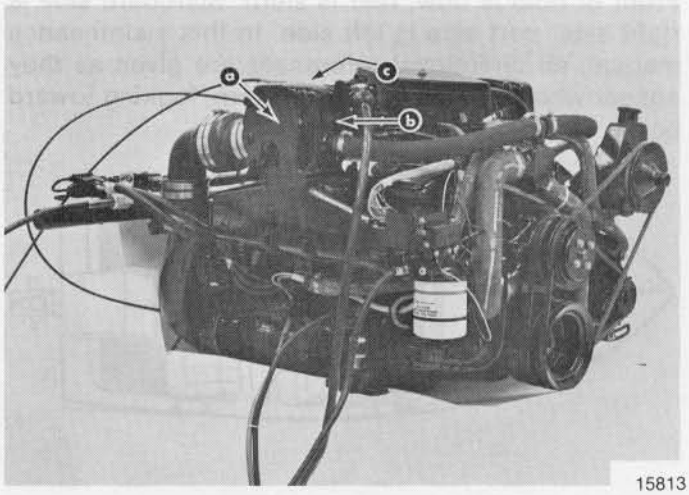
MCM 370 TRS (S.N. 6721527 and Below)/400 TRS/ 400 Cyclone/440 Cyclone/460 Cyclone/230 TR/260 TR



15022

a - Serial Number Plate
b - Starter Motor

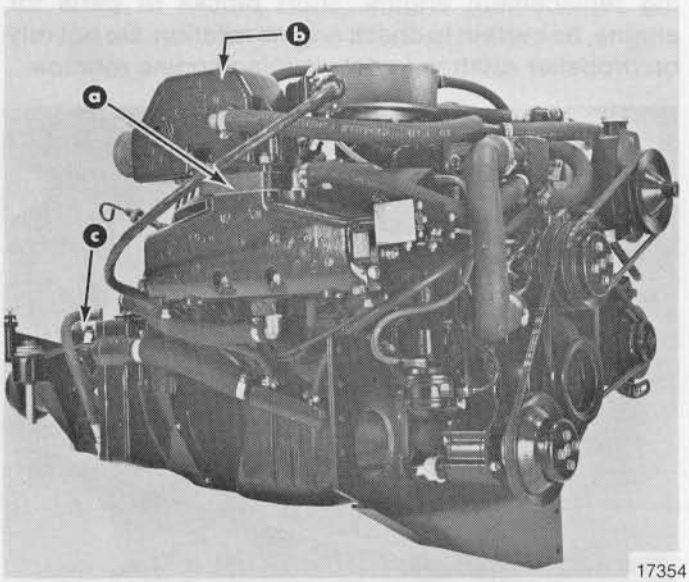
MIE 230/260/340/5.7 Ski/5.0 Litre/5.7 Litre/7.4 Litre



15813

a - Exhaust Elbow Mounted In Center of Manifold
b - Shift Plate On Side of Exhaust Elbow
c - Thunderbolt IV (HEI) Ignition System

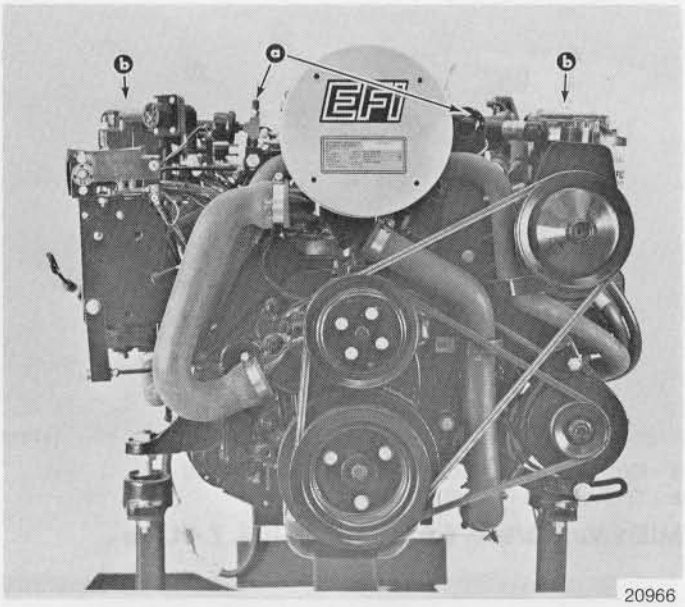
MCM 200, 230, 260, 300 Tempest Alpha One, 350 Magnum, 454 Magnum, 5.0 Litre, 5.0 Litre LX, 5.7 Litre, 7.4 Litre



17354

a - Center Mounted Exhaust Elbow
b - Thunderbolt IV (HEI) Ignition System
c - Borg-Warner Transmission

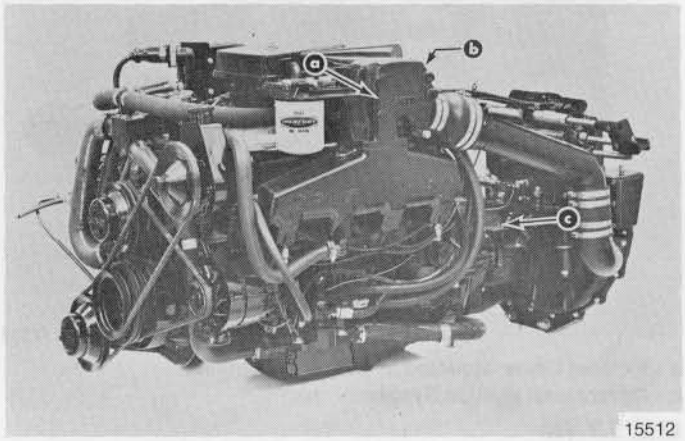
MCM 300 Tempest TRS



20966

a - EFI System
b - Center Mounted Exhaust

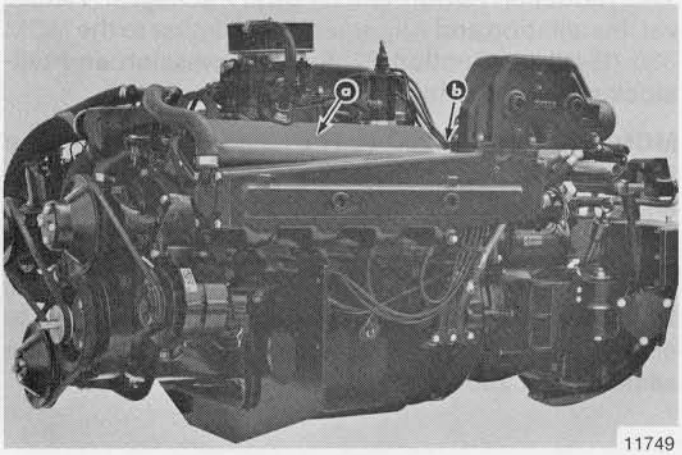
MCM 320 EFI



15512

a - Center Mounted Exhaust Elbow
b - Thunderbolt IV (HEI) Ignition System
c - Borg-Warner Transmission

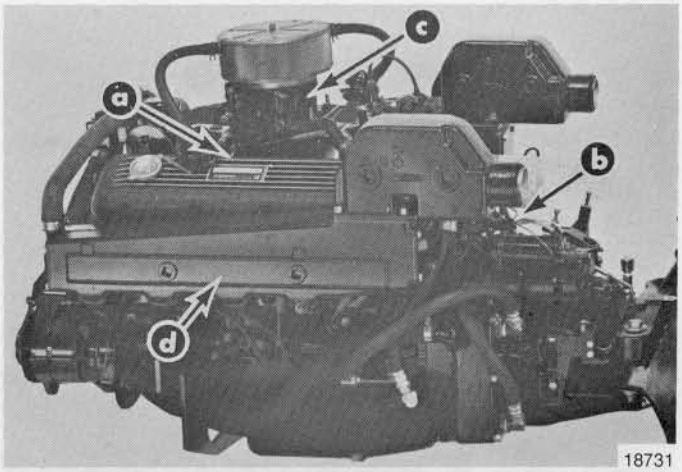
MCM 330 (B/W)/370 TRS (S.N. 6721528 and Above)



11749

a - Rocker Arm Cover Decal - "370" or "Series 400"
b - Serial Number Plate on Flywheel Housing - "370" Stamped in Plate

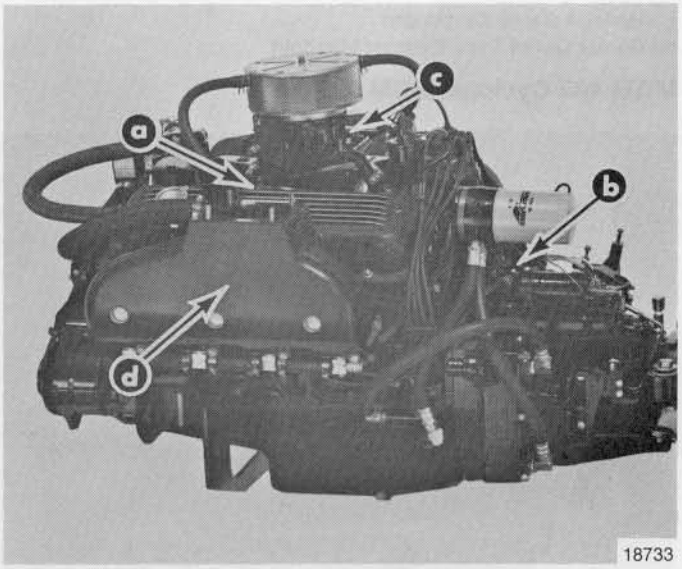
MCM 370 TRS (S.N. 6721527 and Below)



18731

a - Rocker Arm Cover Decal - "400"
b - Serial Number Plate on Flywheel Housing "400" Stamped in Plate
c - Rochester 4 Barrel Carburetor
d - 370 Type Exhaust Manifold and Elbow

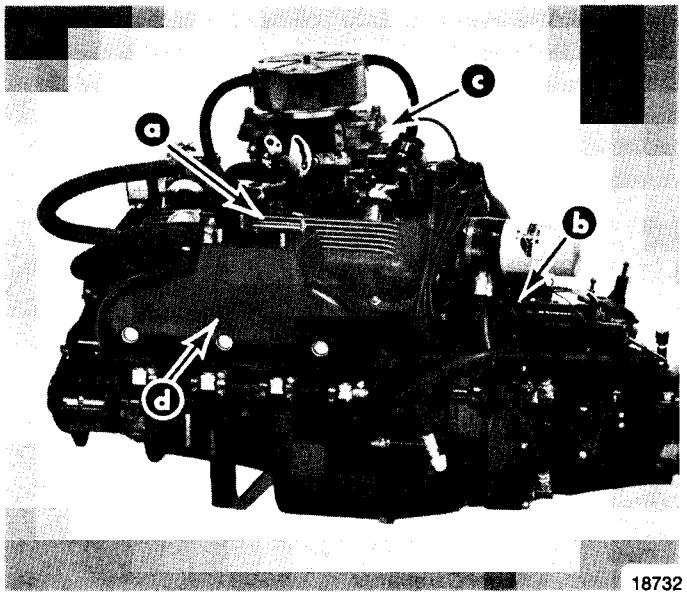
MCM 400 Cyclone



18733

a - Rocker Arm Cover Decal - "440"
b - Serial Number Plate on Flywheel Housing - "440" Stamped in Plate
c - Early Models Had Rochester 4 Barrel Carburetor, Later Models Had Holley 4 Barrel Carburetor
d - Center Outlet Type Exhaust Manifold

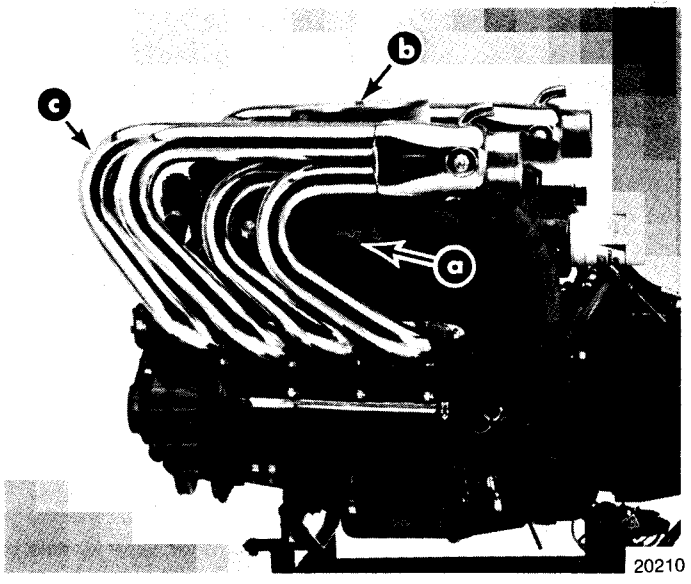
MCM 440 Cyclone



18732

a - Rocker Arm Cover Decal - "460" or "420"
b - Serial Number Plate on Flywheel Housing - "460" Only Serial Number Plate on Starboard Side, Rear of Engine Block "420" Only
c - Holley 4 Barrel Carburetor
d - Center Outlet Type Exhaust Manifold

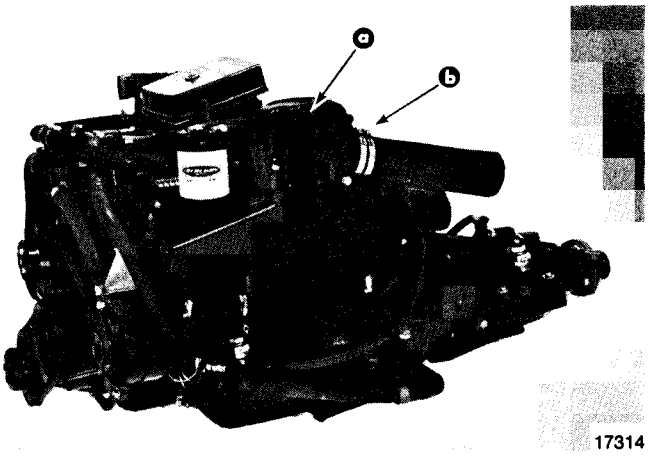
MCM 460 Cyclone/MCM 420



20210

a - Rocker Arm Decal "575"
b - Holley 4 Barrel Carburetor
c - "Stelling" Exhaust "Headers"

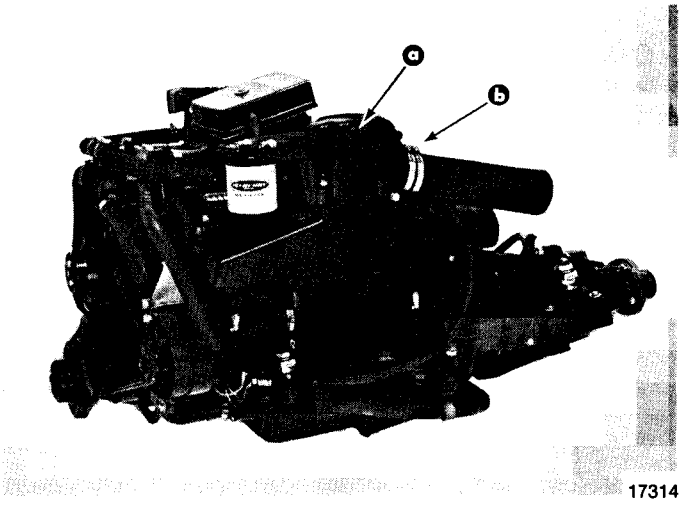
MCM 575



17314

a - Exhaust Elbow Mounted in Center of Manifold
b - Thunderbolt IV (HEI) Ignition System

MIE 230/260/340, 5.0 Litre, 5.7 Litre, 7.4 Litre



17314

a - Exhaust Elbow Mounted in Center of Manifold
b - Coventional Ignition System

MIE 5.7 Ski

MCM 230TR/260TR

Mercury Marine Hi-Performance Products has built 2 TR Production Performance Power Packages. "Removal, Installation and Alignment" are similar to the MCM 330 (B-W) in "Section 2". For transmission and tailstock repair, refer to "Section 8".

MCM 230TR: MIE 230 (L.H.) inboard engine with a Borg-Warner transmission (for TR package) added to engine. Repair and specifications for engine is the same as MIE 230.

MCM 260TR: MIE 260 (L.H.) inboard engine with a Borg-Warner transmission (for TR package) added to engine. Repair and specifications for engine is the same as MIE 260.

Propeller Information

Refer to the "Propeller" Section in appropriate MerCruiser Stern Drive Service Manual, or order publication P/N 90-86144 "What You Should Know About Quicksilver Propellers".

Changing diameter, pitch or coupling of a propeller will affect engine RPM and boat performance. The blade configuration also will affect performance. Two like propellers, same pitch and diameter, from two different manufacturers also will perform differently.

It is the responsibility of the boat manufacturer and/or selling dealer to equip the boat with the correct propeller to allow the engine to operate within its specified RPM range at wide open throttle (W.O.T).

Because of the many variables of boat design and operation, only testing will determine the best propeller for the particular application.

To test for correct propeller, operate boat (with an average load onboard) at W.O.T. and check RPM with an accurate tachometer. Engine RPM should be near top of the specified range so that, under heavy load, engine speed will not fall below specifications.

If engine exceeds the specified RPM, an increase in pitch and/or diameter is required.

If engine is below rated RPM, a decrease in pitch and/or diameter required.

Normally, a change of approximately 300 to 500 RPM will be achieved for each single pitch change of propeller.

⚠CAUTION

If a propeller is installed that does not allow engine RPM to reach the specified full-throttle RPM range, the engine will "labor" and will not produce full power. Operation under this condition will cause excessive fuel consumption, engine overheating and possible piston damage (due to detonation). On the other hand, installation of a propeller, that allows engine to run above the specified RPM limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.

Hi-Performance Boating

Written by Marine Engineers, order publication P/N 90-86168, entitled "Hi-Performance Boat Operation.

Engine 20-Hour Break-In Period

IMPORTANT: Proper break-in is essential to obtaining minimum oil consumption, maximum engine performance and service.

The first 20 hours of operation is the engine (new or rebuilt) break-in period. During this period, it is extremely important that the engine is operated, as outlined following.

1. Do not operate engine below 1500 RPM for extended periods of time during the first 10 hours. During this period, shift into gear as soon as possible after starting engine and advance throttle so that RPM is above 1500 (provided that conditions permit safe operation at this speed).
2. Do not operate at any one constant speed for extended periods of time.
3. Do not exceed 3/4 of full throttle during the first 10 hours of operation. During the next 10 hours, occasional operation at full throttle (5 minutes at-a-time maximum) is permissible.
4. Avoid full throttle acceleration from stopped position.
5. Do not operate at full throttle until engine reaches normal operating temperature.
6. Observe instrumentation carefully. If an abnormal reading occurs, stop engine immediately and determine cause.
7. Frequently check crankcase oil level and add oil if necessary. It is normal for oil consumption to be somewhat high during the break-in period.
8. At end of 20-hour break-in period, drain break-in oil from crankcase and replace oil filter. Fill crankcase with correct grade and viscosity oil.

Water Testing New Engines

Use care during the first 20 hours of operation on new MerCruiser engines or possible engine failure may occur. If a new engine has to be water-tested at full throttle before the break-in period is complete, follow this procedure.

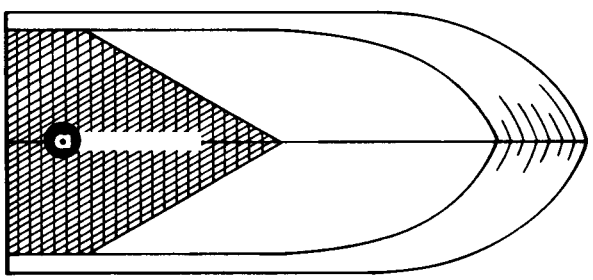
1. Start engine and run at idle RPM until normal operating temperature is reached.
2. Run boat up on plane.
3. Advance engine RPM (in 200 RPM increments) until engine reaches its maximum rated RPM.

IMPORTANT: Do not run at maximum RPM for more than 2 minutes.

Boat and Engine Performance

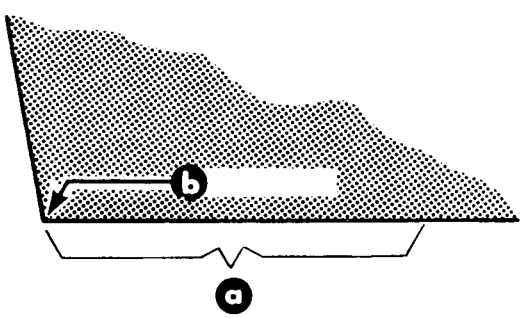
Boat Bottom

For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft. (1.5m).



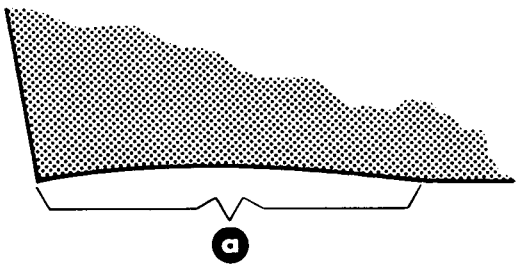
a - Critical Bottom Area

For best speed and minimum spray, the corner between the bottom and the transom should be sharp.



a - Flat
b - Sharp Corner

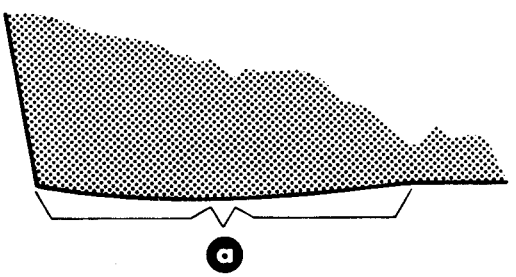
The bottom is referred to as having a "hook" if it is concave in the fore-and-aft direction. A hook causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed. A hook, however, aids in planing and reduces any porpoising (rhythmical bouncing) tendency. A slight hook is often built in by the manufacturer. A hook also can be caused by incorrect trailering or storing the boat with support directly under the transom.



a - Hook

A "rocker" is the reverse of a hook. The bottom is convex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.

Any hook, rocker or surface roughness on the bottom, particularly in the all-important center-aft portion will have a negative effect on speed, often several miles-per-hour on a fast boat.



a - Rocker

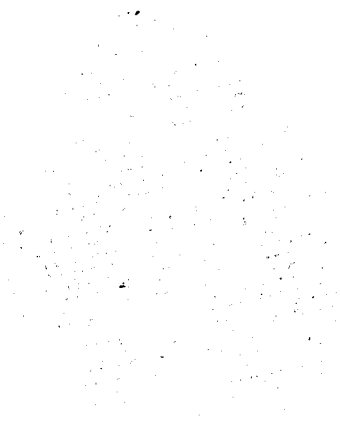
Marine Fouling

Fouling is an unwanted build-up (usually animal-vegetable-derived) occuring on the boat's bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic build-up of material quickly. So it is important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Special hull treatments, such as anti-fouling paint, will reduce the rate of bottom fouling. However, due to the fact that drive units (outboard or stern drive) are made primarily of aluminum, be sure to select an anti-fouling paint having a copper-free, organo-tin base. The BIS (Tri Butyl Tin) Adipate (TBTA) base paint will not set up a galvanic corrosion "cell" as it is completely compatible with aluminum and avoids any electrolysis problems connected with many other paints. Applied according to instructions, it also is very effective.

Weight Distribution

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed, all movable weight — cargo and passengers — should be as far aft as possible to allow the bow to come up to a more effecient angle (3° to 5°). On the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.



Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suits his/her needs.

Weight and passenger loading placed well forward increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

Water in Boat

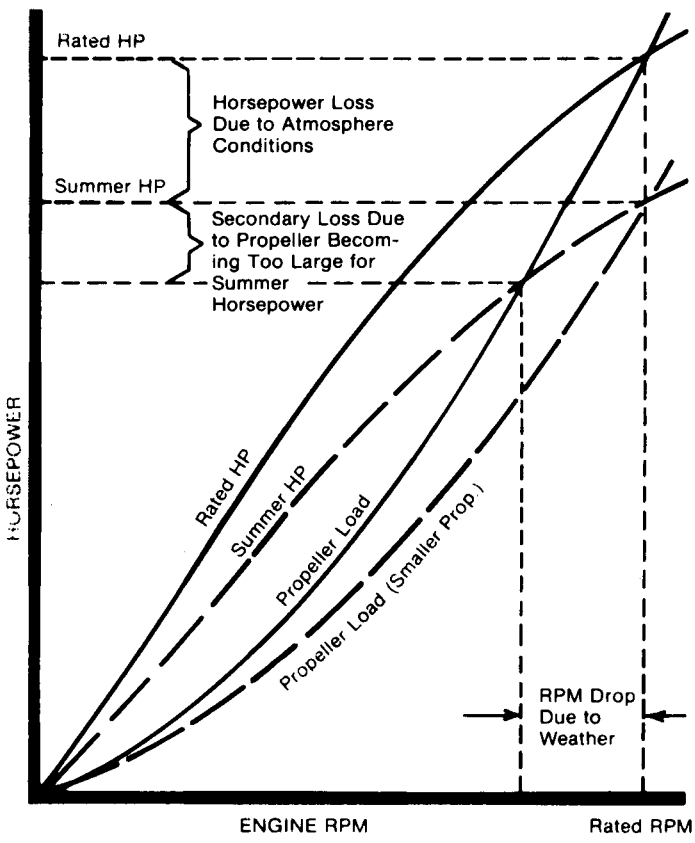
When a boat loses performance, check bilge for water. Water can add considerable weight to the boat, thereby decreasing the performance and handling.

Make certain that all drain passages are open for complete draining.

Elevation and Climate

Elevation has a very noticeable effect on the wide-open throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly annoying when an engine is propped out on a cool, dry day in spring and later, on a hot, sultry day in August, does not have its old zip. (See chart)

Although some performance can be regained by dropping to a lower-pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver Propeller Repair Station can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, a gear-ratio change to the drive unit to more reduction is possible and very beneficial. It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.



MAINTENANCE

1B

Location and Service	When Starting Engine Each Day	After First 20 Hours of Operation	Every 50 Hours of Operation
Engine Crankcase Oil - Check level	•		
Closed Cooling Coolant - Check coolant level	•		
Remote Control and Steering System - Check for proper operation	•		
Power Package (Entire) - Observe for obvious leaks (water, fuel, oil, exhaust, etc.)	•		
Ignition System - Check timing and adjust, if necessary		•	
Crankcase Oil and Oil Filter - Change		•	

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Maintenance Schedule

NOTE: Refer to the end of this chart for explanation of lettered references (A, B, C) and "NOTES".

⚠WARNING

Always disconnect battery cables from battery BEFORE working around electrical system componenets to prevent injury to yourself or damage to electrical system should a wire be accidentally shorted.

Location and Service	When Starting Engine Each Day	After First 20 Hours of Operation	Every 50 Hours of Operation	Every 100 Hours of Operation	At Least Once Each Year
Closed Cooling Models Only - Check coolant level.	●				
Engine Crankcase Oil - Check level	●				
Power Package (Entire) - Observe for obvious leaks (water, fuel, oil, exhaust, etc.)	●				
Remote Control and Steering System - Check for proper operation	●				
Transmission oil level (if equipped) (A)	●				
Cooling System Hose Clamps - Check tightness.		●		● Note 1	●
Drive Belts (All) - Inspect condition and check tension.		●		●	●
Exhaust System - Inspect condition. Check hose clamps for adequate tightness.		●		● Note 1	●
Ignition System - Clean and inspect condition		●		● Note 1	●
Power Package (Entire) - Check for loose, missing or damaged parts, (especially engine mount fasteners and starter, and alternator mounting fasteners).		●		●	●
Crankcase Oil and Oil Filter - Change		●	Refer to Page		●
Engine Alignment - Check		●			●
Ignition System - Check timing and adjust, if necessary.		●			●
Battery - Check electrolyte level and specific gravity. Inspect case for damage.			●		●
Electrical System (Entire) - Check loose or dirty connections or damaged wiring (especially battery cables).			● Note 2		●
Fuel Pump Sight Tube (or Glass) - Check for evidence of fuel.			●		●
Flame Arrestor and Crankcase Ventilation System - Clean and inspect				●	●
Hoses (All) - Inspect for cracks, swelling, weather checking or other signs of deterioration. Check connections for adequate tightness.				●	●

Location and Service	When Starting Engine Each Day	After First 20 Hours of Operation	Every 50 Hours of Operation	Every 100 Hours of Operation	At Least Once Each Year
Shift and Throttle Cable and Linkage - Lubricate and inspect. (B)				● Note 1	●
Lubricate starter motor (C)				● Note 1	●
Fuel Filters - Replace					●
Carburetor/EFI adjust	As Required				
Closed Cooling Models Only - Clean closed cooling section	As Required NOTE 3				
Closed Cooling Models Only - Check coolant for alkalinity	At Least Once A Year				
Power Package Exterior Surfaces - Spray with rust preventive. (D)	Fresh Water Areas - Every 6 Weeks Salt Water Areas - Every 2-3 Weeks				
Seawater Cooling System - Flush (CORROSIVE AREAS ONLY)	After Use Each Day				

(A) Use Automatic Transmission Fluid (ATF), Type F, Dexron or Dexron II.
(B) Use SAE 30 engine oil.
(C) Use Lubriplate Extra-Heavy Gear Shield or its equivalent.
(D) Use Quicksilver Corrosion and Rust Preventive Type II.

NOTES: (1) In fresh water areas, every 100 hours of operation or 120 days (whichever comes first). In saltwater areas, every 50 hours of operation or 60 days (whichever comes first).
(2) In fresh water areas, every 50 hours of operation or 60 days (whichever comes first). In saltwater areas, every 25 hours of operation or 30 days (whichever comes first).
(3) Requires more frequent attention, if used in extremely salty, polluted or mineral-laden waters.

Tune-Up Specifications

MODEL	MCM 200, 5.0 Litre	MCM 230, 5.0 Litre LX	MCM 260/350 Magnum/5.7 Litre
Horsepower (Kilowatts)	200 (149)	230 (172)	260 (194)
Number of Cylinders	V-8		
Displacement	305 CID (5L)		350 CID (5.7L)
Bore/Stroke	3.74 In./3.48 In. (98/88.4mm)		4.00 In./3.48 In. (101.6/88.4mm)
Compression Ratio	8.5:1		
Compression Pressure	150 PSI (1035 kPa)	155 PSI (1069 kPa)	150 PSI (1035 kPa)
Idle RPM (In Forward Gear)	650-700		
Max. RPM (At W.O.T.)	3800-4200	4200-4600	
Oil PSI (At 2000 RPM)	30-55 PSI (207-379 kPa)		
Min. Oil PSI (At Idle)	4 PSI (28 kPa)		
Fuel Pump PSI (At 1800 RPM)	5-1/2 - 7 PSI (38 - 48 kPa)		
Electrical System	12 Volt Negative (-) Ground		
Min. Battery Cold Cranking Amps	305		350
Firing Order	1-8-4-3-6-5-7-2		
Spark Plug Type	AC-MR43T Champion - RV8C Autolite-144 NGK-BR6FS		
Spark Plug Gap	.035 In. (.9mm)		
Timing (At Idle RPM)	8° BTDC		
Preliminary Idle Mixture	1-1/4 Turns	2-3 Turns	
Thermostat	143°F (62°C)		

Tune-Up Specifications

MODEL	7.4 Litre, MCM 330 B/W 454 Magnum	MCM 370TRS (S.N. 6721528 and Above)	MCM 370TRS (S.N. 6721527 and Below)/400TRS	454 Magnum (1988)
Horsepower (Kilowatts)	330 (246)	370 (276)		365 (272)
Number of Cylinders	V-8			
Displacement	454 Cubic Inches (7.4L)			
Bore/Stroke	4.25 In./4.00 In. (108mm/102mm)			
Compression Ratio	8.5:1	8.6:1		
Compression Pressure	150 P.S.I. (1035 kPa)			
Idle RPM (In Forward Gear)	650-700	800-850		650-700
Max. RPM (At W.O.T.)	4200-4600	4800-5200		4600-5000
Oil PSI (At 2000 RPM)	35-70 P.S.I. (241-483 kPa)			
Min. Oil PSI (At Idle)	4 P.S.I. (28 kPa)	5 P.S.I. (34 kPa)		
Fuel Pump PSI (At 1800 RPM)	5.5-7 P.S.I. (38-48 kPa)	3-5 P.S.I. (21-34 kPa)	5.25-6.5 P.S.I. (36-45 kPa)	3-7 P.S.I. (21-48 kPa)
Electrical System	12-Volt Negative (-) Ground			
Min. Battery Cold Cranking Amps	450			
Firing Order	1-8-4-3-6-5-7-2			
Spark Plug Type	AC-M43T, Champion RV8C, Autolite-144, NGK-BR6FS			
Spark Plug Gap	.035 In. (0.9mm)			
Breaker Point Gap			.016 - .019 In. (0.40 - 0.48mm)	
Dwell			26° - 31°	
Breaker Point Spring Tension			25 - 30 Oz. (709 - 850g)	
Timing (At Idle RPM)	8° BTDC	10° BTDC		8° BTDC
Preliminary Idle Mixture	2-3 Turns			
Thermostat	143° F (62° C)			

Tune-Up Specifications

MODEL	MCM 300 Tempest All Drives	MCM 320 EFI All Drives
Horsepower (Kilowatts)	300 (224)	320 (239)
Number of Cylinders	V-8	
Displacement	350 Cu. In. (5.7 L)	
Bore/Stroke	4.00 In./3.48 In. (102/88mm)	
Compression Ratio	9:1	
Compression Pressure	150 P.S.I. (1035 kPa)	
Idle RPM (In Forward Gear)	750-800	
Max. RPM (At W.O.T.)	4800 - 5200	
Oil PSI (At 2000 RPM)	30 - 60 P.S.I. (207 - 414 kPa)	
Min. Oil Pressure (At Idle)	5 P.S.I. (34 kPa)	
Fuel Pump Pressure	3-7 P.S.I. (21-48 kPa)	29 P.S.I. (269 kPa) Above Intake Manifold Pressure
Electrical System	12-Volt Negative (-) Ground	
Min. Battery Cold Cranking Amps	350	
Firing Order	1-8-4-3-6-5-7-2	
Spark Plug Type	AC-MR43T, Champion RV8C, Autolite 144, NGK-BR6FS	
Spark Plug Gap	.032 In. (0.8mm)	
Timing (At Idle RPM)	8° BTDC	12° BTDC
Preliminary Idle Mixture	2-3 Turns	
Thermostat	143° (62° F)	

Tune-Up Specifications

MODEL	MCM 230TR	MCM 260 TR 5.7 Litre
Horsepower (Kilowatts)	230 (172)	260 (194)
Number of Cylinders	V-8	
Displacement	305 Cu. In. (5L)	350 Cu. In. (5.7L)
Bore/Stroke	3.74/3.48 In. (95/88mm)	4.00/3.48 In. (102/88mm)
Compression Ratio	8.5:1	
Compression Pressure	155 P.S.I. (1069 kPa)	150 P.S.I. (1035 kPa)
Idle RPM (In Forward Gear)	650-700	
Max. RPM (At W.O.T.)	4000-4400	
Oil Pressure (At 2000 RPM)	30-55 P.S.I. (207-379 kPa)	
Min. Oil Pressure (At Idle)	4 P.S.I. (28 kPa)	
Fuel Pump Pressure	5.5-7 P.S.I. (38-48 kPa)	
Electrical System	12-Volt Negative (-) Ground	
Min. Battery Cold Cranking Amps	305	350
Firing Order	1-8-4-3-6-5-7-2	
Spark Plug Type	AC-MR43T Autolite-144	Champion RV8C, NGK-BR6FS
Spark Plug Gap	.035 In. (0.9mm)	
Timing (At Idle RPM)	8° BTDC	
Preliminary Idle Mixture	2-3 Turns	
Thermostat	143° F (62° C)	

Tune-Up Specifications

MODEL	MCM 420 HP 420	MCM 400 CYCLONE	MCM 440 CYCLONE	MCM 460 CYCLONE	MCM 575 HP 575
Horsepower (kilowatts)	420 (313)	400 (298)	440 (328)	460 (343)	575 (429)
Number of Cylinders	V-8				
Displacement	454 CID (7.4L)			482 CID (7.9L)	540 CID (8.9L)
Bore/Stroke	4.25 In./4.00 In. (108mm/102mm)			4.25 In./4.25 In. (108/108mm)	4.440 In./ 4.375 In. (113/111mm)
Compression Ratio	8.6:1			9.2:1	8.75:1
Compression Pressure	150 PSI (1035 kPa)			160 PSI (1103 kPa)	150 PSI (1035 kPa)
Idle RPM (In Forward Gear)	800-850				950
Max. RPM (At W.O.T.)	4800-5200			4800-5400	4800-5200
Oil PSI (At 2000 RPM)	35-70 PSI (241-483 kPa)				
Min. Oil PSI (At Idle)	5 PSI (35 kPa)				
Fuel Pump PSI (At 1800 RPM)	5-7 PSI (35-48 kPa)				
Electrical System	12-Volt Negative (-) Ground				
Min. Battery Cold Cranking Amps	450				
Firing Order	1-8-4-3-6-5-7-2				
Spark Plug Type	AC-MR 43T Autolite-144		Champion RV8C NGK-BR6FS	AC-MR41T	
Spark Plug Gap	.035 In. (.9mm)				
Breaker Point Gap		.016-.019 In. (0.40-0.45mm)			
Dwell		28°-31°			
Breaker Point Spring Tension		25-30 Oz. (709-850g)			
Timing (At Idle RPM)	10° BTDC		15° BTDC		10° BTDC
Preliminary Idle Mixture	2-3 Turns				1-1/4 Turns
Thermostat	143° F (62° C)				
Valve Lash	0				.025 In. (.65mm)

Tune-Up Specifications

MODEL	MIE 230/ 5.0 LITRE	MIE 260/ 5.7 LITRE	MIE 340/ 7.4 LITRE
Horsepower (Kilowatts)	230 (172)	260 (194)	340 (254)
Number of Cylinders	V-8		
Displacement	305 CID (5L)	350 CID (5.7L)	454 CID (7.5L)
Bore/Stroke	3.74 In./3.48 In. (95/88mm)	4.00 In./3.48 In. (102/88mm)	4.25 In./4.00 In.) (108/102mm)
Compression Ratio	8.5:1		
Compression Pressure	155 PSI (1069 kPa)	150 PSI (1035 kPa)	
Idle RPM (In Forward Gear)	650-700		
Max. RPM (At W.O.T.)	4000-4400		
Oil PSI (At 2000 RPM)	30-50 PSI (207-379 kPa)		30-70 PSI (207-483 kPa)
Min. Oil PSI (At Idle)	4 PSI (28 kPa)		
Fuel Pump PSI (At 1800 RPM)	5-1/2-7 PSI (38-48 kPa)		
Electrical System	12-Volt Negative (-) Ground		
Min. Battery Cold Cranking Amps	305	350	450
Firing Order	L.H. Rot. 1-8-4-3-6-5-7-2	R.H. 1-2-7-5-6-3-4-8	
Spark Plug Type	AC-MR43T Autolite-144	Champion RV8C NGK-BR6FS	
Spark Plug Gap	.035 In. (0.9mm)		
Timing (At Idle RPM)	8° BTDC		
Preliminary Idle Mixture	2-3 Turns		
Thermostat	143° F (62° C)		

Tune-Up Specifications

MODEL	MIE 5.7 Ski/5.7 Litre Comp Ski
Horsepower (Kilowatts)	260 (194)
Number of Cylinders	V-8
Displacement	350 Cu. In. (5.7L)
Bore/Stroke	4.00/3.48 In. (102/88mm)
Compression Ratio	9:1
Compression Pressure	150 P.S.I. (1035 kPa)
Idle RPM (In Forward Gear)	650-700
Max. RPM (At W.O.T.)	4000-4400
Oil Pressure (At 2000 RPM)	30-55 P.S.I. (207-379 kPa)
Min. Oil Pressure (At Idle)	4 P.S.I. (28 kPa)
Fuel Pump Pressure	3-7 P.S.I. (21-48 kPa)
Electrical System	12-Volt Negative (-) Ground
Min. Battery Cold Cranking Amps	350
Firing Order	L.H. Rot. 1-8-4-3-6-5-7-2 R.H. Rot. 1-2-7-5-6-3-4-8
Spark Plug Type	AC-MR43T Champion RV8C, Autolite-144 NGK-BR6FS
Spark Plug Gap	.035 In. (0.9mm)
Breaker Point Gap	.016-.019 In. (0.40-0.48mm)
Dwell	28° - 31°
Breaker Point Spring Tension	25-30 Oz. (709-850g)
Timing (At Idle RPM)	10° BTDC
Preliminary Idle Mixture	2-3 Turns
Thermostat	143° F (62° C)

Fluid Capacities

NOTICE
All capacities are approximate fluid measures.

MODEL	MCM 200/ 5.0 Litre	MCM 230/ 5.0 Litre LX	5.7 Litre MCM 260/ 350 Magnum	MCM 300 Tempest/ 320 EFI Alpha One	MCM 300 Tempest/ 320 EFI TRS
Crankcase (with Filter)	5 Qts. (4.7L)	5-1/2 Qts. (5.2L)		6-1/2 Qts. (6L)	
Standard Cooling System	15 Qts. (14.1L)				
Closed Cooling System	20 Qts. (19L)				
Transmission					2.1 Qts. (2L)

MODEL	MCM 454 Magnum 7.4 Litre	MCM 330 B/W	MCM 370TRS/400 TRS
Crankcase (with Filter)	7 Qts. (6.6L)		6 Qts. (5.6L)
Standard Cooling System	20 Qts. (19L)		
Closed Cooling System		28 Qts. (26.5L)	
Transmission		2 Qts. (1.8L)	

MODEL	MCM 400/440 CYCLONE	MCM 460 CYCLONE	MCM 420 HP 420	MCM 575 HP 575
Crankcase (with Filter)	7 Qts. (6.6L)	10 Qts. (9.4L)	6 Qts. (5.7L)	7 Qts. (6.6L)
Standard Cooling System	20 Qts. (19L)			
Transmission (Approx.)	2 Qts. (1.8L)			

MODEL	MCM 230TR	MCM 260TR/ 5.7 Litre
Crankcase (with Filter)	6 Qts. (5.6L)	
Standard Cooling System	15 Qts. (14.1L)	
Closed Cooling System	20 Qts. (19L)	
Transmission	2 Qts. (1.8L)	

MODEL	MIE 230/ 5.0 Litre	MIE 260/ 5.7 Litre	MIE 340/ 7.4 Litre
Crankcase (with Filter)	6 Qts. (5.6L)		7 Qts. (6.6L)
Standard Cooling System	15 Qts. (14.1L)		20 Qts. (19L)
Closed Cooling System	20 Qts. (19L)		28 Qts. (26.5L)
Transmission 1:1	2 Qts. (1.8L)		
Transmission 1.5:1-3.0:1	3 Qts. (2.8L)		
Transmission V-Drive	4-1/2 Qts. (4.2L)		

MODEL	MIE 5.7 Ski 5.7 Litre Comp Ski
Crankcase (with Filter)	4 Qts. (3.8L)
Standard Cooling System	15 Qts. (14.1L)
Transmission In-Line Direct Drive	2 Qts. (1.9L)
Transmission In-Line with Reduction	3 Qts. (2.9L)

Fuel, Oil, Fluid and Coolant Specifications

FUEL

⚠CAUTION

Use of improper gasoline can damage the engine seriously. Engine damage, that results from use of improper gasoline, is considered misuse of the engine and is not covered under MerCruiser Warranty.

The use of any good grade regular leaded, premium, low-lead or lead-free automotive gasolines with a minimum posted octane rating of 86 (research octane number 90), are satisfactory for use in MerCruiser marine engines. [Hi-Performance models: Minimum posted octane rating of 88 (research octane number 93). If 88 octane is not available, a gasoline with an average octane rating as low as 86 (research octane number 90) may be used; however, ignition timing must be retarded 4° to prevent harmful detonation.]

However, gasolines containing alcohol, either methyl alcohol (methanol) or ethyl alcohol (ethanol) may cause increased:

- Corrosion of metal parts.
- Deterioration of elastomer and plastic parts.
- Fuel permeation through flexible fuel lines.
- Wear and damage of internal engine parts.
- Starting and operating difficulties.

Some of these adverse effects are due to the tendency of gasolines containing alcohol to absorb moisture from the air, resulting in a phase of water and alcohol separating from the gasoline in the fuel tank.

The adverse effects of alcohol are more severe with methyl alcohol (methanol) and are worse with increasing alcohol content.

⚠WARNING

FIRE AND EXPLOSION HAZARD: Fuel leakage from any part of the fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of the entire fuel system is mandatory, particularly after storage. All fuel components including fuel tanks, whether plastic, metal or fiberglass, fuel lines, fittings, fuel filters, fuel pumps and carburetors should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration necessitates replacement before further engine operation.

Because of the possible adverse effects of alcohol in gasoline, it is recommended that only alcohol free gasoline be used where possible. If only alcohol containing fuel is available, or if the presence of alcohol is unknown, then increased inspection frequency for leaks and abnormalities is required.

No Lead Gasoline/Alcohol Blends

LEAD

Recent regulations by the U.S. Enviromental Protection Agency (EPA) and the Canadian government have required the removal of lead (anti-knock compound) from all gasoline by 1988 due to the lead emission in exhaust being a health hazard.

In order to maintain octane ratings, many gasoline manufactures are adding ethyl alcohol (ethanol) or methyl alcohol (methanol) to the gasoline to replace the lead.

Since 1975, Mercury Marine has recommended operation of MerCruiser marine engines with any good grade regular leaded, premium, low-lead or no-lead gasolines with a minimum average octane rating of 88. Prior to that time, recommendations were to use one tank of leaded gasoline for every four tanks of no-lead gasoline. Mercury Marine has recently amended its fuel recommendations for MerCruiser engines.

NO LEAD GASOLINE WITH A MINIMUM POSTED AVERAGE OCTANE RATING OF 86, MAY BE USED IN MERCRUISER MARINE ENGINES AS STATED ABOVE. (HI-PERFORMANCE MODELS ARE EXCEPTIONS.)

GASOLINE/ALCOHOL BLENDS

Many new motor vehicle owner manuals are warning about the potential damage from using gasoline containing alcohol, especially **METHANOL.** They cite possible fuel system damage and performance problems. These are just two of the hazards that may be caused by alcohol. These same problems as well as the additional safety risk of fire and explosion from fuel system leaks apply to marine inboard engines. **METHANOL** is more severe in its bad effect than is **ETHANOL.** Alcohol is also more severe in older engines since newer engines have materials which are more resistant to alcohol.

Effects of Gasoline/Alcohol Blends on Marine Engines

Corrosion of metals may result from use of alcohol-gasoline blends. Portable or permanently installed fuel tanks of metal or fiberglass, fuel filters, fuel lines and float bowls may be affected by alcohol blended fuels. Many fiberglass fuel tanks are slowly dissolved by alcohol, leading immediately to filter and carburetor plugging and eventually to tank failure.

Alcohol containing fuels will absorb moisture from the air. At first, this moisture will remain in solution, but once the water content of the fuel has built up to about one-half of one percent, it will separate out, (phase separation) bringing the alcohol with it. This alcohol-water mixture settles to the bottom of the fuel tank and if this mixture gets into the engine, engines can be seriously damaged internally, as it may wash the protective film of oil off the bore of any cylinder that it enters. Before the engine can be restarted, it is necessary to remove the separated alcohol and water layer, flush out the fuel system with clean fuel and remove and dry the spark plugs.

BOAT/MOTOR STORAGE

When operating a MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods of time should be avoided.

Long periods of storage, common to boats, create unique problems. In cars, gasoline/alcohol blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

WINTER STORAGE

If boat is to be placed in winter storage, carburetors must be run dry at idle RPM. Permanent fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Portable fuel tanks should be emptied completely.

WARRANTY

Performance problems, fuel system or other damage resulting from the use of gasoline-alcohol blended fuels is not the responsibility of Mercury Marine and will not be covered under our warranty.

CONTINUING EVALUATIONS

The effects of gasoline blended with ETHANOL and METHANOL are still being evaluated by the United States Coast Guard, the National Marine Manufacturers Association (NMMA), Mercury Marine and other engine and boat manufacturers.

We have recommended pump posting of alcohol content of gasoline. Further we recommend using gasoline known not to contain any METHANOL or ETHANOL when possible.

TEST FOR ALCOHOL CONTENT IN GASOLINE

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. (Outboard motors only; Test should be conducted **before the addition of oil** as the oil may obscure any change in separation level.) Use any small transparent bottle or tube that can be capped and is or can be provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

PROCEDURE

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space; then, cap the container. The proportions of fuel to water are not critical, but there should be 2-3 times as much fuel as water.
3. Shake container vigorously and allow it to sit **upright for up to about 3-5 minutes.** If the volume of water appears to have increased, alcohol is present. If you are not sure, there is no need for concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

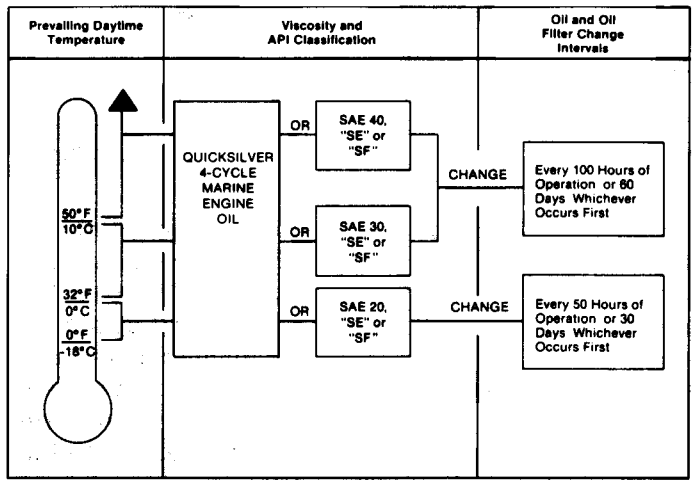
Crankcase Oil

After the 20-hour break-in oil has been drained, select a crankcase oil based on the prevailing daytime temperature in the area in which the boat is operated.

The chart following is the guide to crankcase oil selection and recommended change intervals. Oil filter should always be changed with oil.

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle Marine Engine Oil. If not available, however, a good grade detergent automotive oil of correct viscosity, that has an API classification of "SE" or "SF", may be used.

IMPORTANT: The use of multi-viscosity oils specifically is not recommended for use in MerCruiser Engines. In those areas, however, where the recommended straight weight oil is not available, a multi-viscosity oils (other than 20W-40 or 20W-50), oils which contain "solid" additives, non-detergent oils, or low quality oils specifically are not recommended.



Power Steering Fluid

IMPORTANT: Use only automatic transmission fluid (ATF), Dexron® or Dexron II in Power Steering System.

Transmission Fluid

VELVET DRIVE® (BORG-WARNER)

Dexron® II, Type F, or other hydraulic transmission Fluids which meet the Detroit Diesel Allison Type C3 specifications are recommended for use in all Velvet Drive® marine transmissions.

Coolant

⚠CAUTION

Alcohol or Methanol base anti-freeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

We recommend that the coolant section of Closed Cooling System be filled with a 50/50 mixture of ethylene glycol anti-freeze and water. In areas where the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

MerCruiser V-8 engines can use any type of permanent anti-freeze or any brand anti-freeze solution that meets G.M. specification 1825M.

Maintaining Crankcase Oil Level

Overfilled Engine Crankcase

Overfilled crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm "clatter", on MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to "bleed down". This, in turn, results in rocker arm "clatter" and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the "ADD" mark and the "FULL" mark on the dipstick. To ensure that you are not getting "false reading", make sure the following steps are done before checking the oil level.

- Boat "at rest" in the water, OR
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting "at rest" in the water.
- Allow sufficient time for oil to drain into the crankcase if engine has just been run or oil has just been added.

Checking Engine Oil Level/Filling

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan - approximately 5 minutes.
3. Remove dipstick. Wipe clean and reinstall. Push dipstick all-the-way into dipstick tube.
4. Remove dipstick and note the oil level.
5. Oil level must be between the "FULL" and "ADD" marks.
6. If oil level is below "ADD" mark, proceed to 7 and 8.
7. Remove oil filler cap from valve rocker arm cover.
8. Add required amount of oil to bring level up to, but not over, the "FULL" mark on dipstick.

Changing Oil and Filter

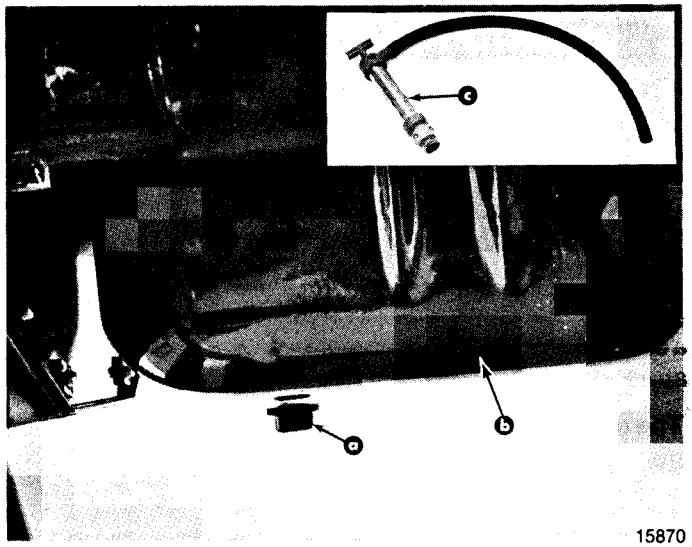
1. Start engine and run until it reaches normal operating temperatures.

IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impuritites.

2. Stop engine.
3. Remove drain plug from oil pan.

NOTE: If drain plug is not accessible because of boat construction, oil may be removed thru dipstick tube, using a Quicksilver Crankcase Oil Pump. (See Quicksilver Accessory Guide)

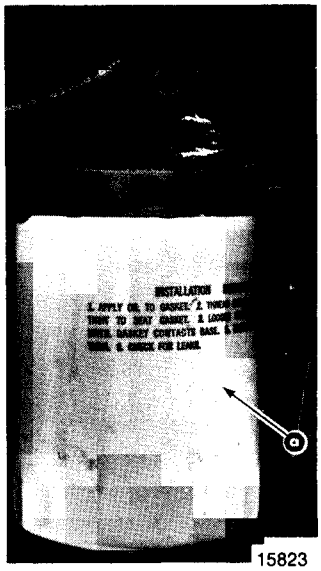
4. After oil has drained completley, reinstall drain plug and tighten securely.



a - Drain Plug
b - Oil Pan
c - Quicksilver Crankcase Oil Pump

Draining Oil (Typical Engine)

5. Remove and discard oil filter and its sealing ring.
6. Coat sealing ring on new filter with engine oil, and install new filter. Tighten filter securely (following filter manufacturer's instructions). Do not overtighten.
7. Fill crankcase with oil.



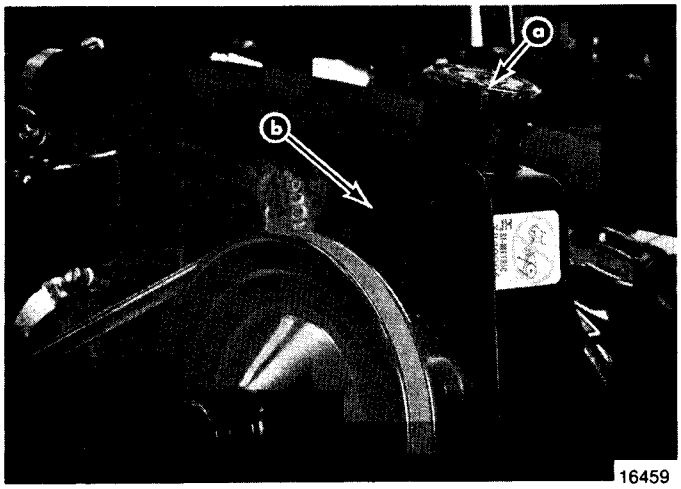
a - Oil Filter
b - Sealing Ring

Changing Oil Filter (Typical Engine)

Maintaining Power Steering Pump Fluid Level

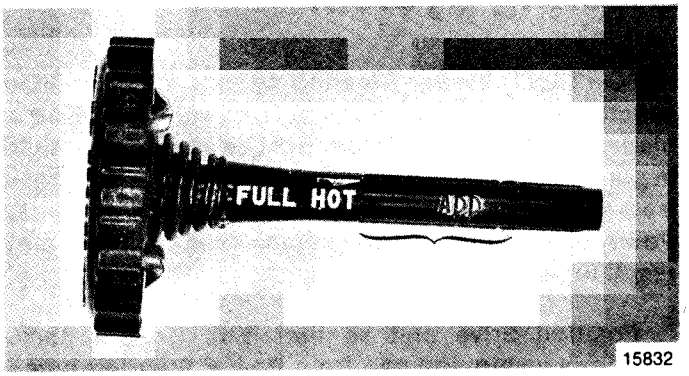
With Engine Warm From Operation

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level.



a - Fill Cap/Dipstick
b - Pump

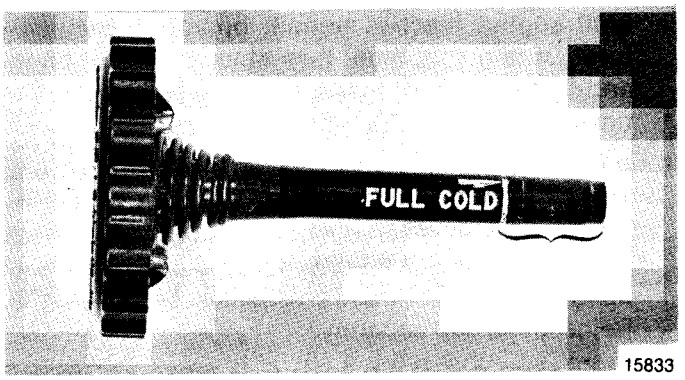
3. Level should be between the "FULL HOT" mark and "ADD" mark on dipstick.



4. If level is low (below "ADD" mark), but fluid is still visible in pump reservoir, add required amount of automatic transmission fluid (ATF), type "F", Dexron, or Dexron II, thru fill cap opening, to bring level up to "FULL HOT" mark on dipstick - do not overfill.
5. If fluid is not visible in reservoir, a leak exists in the Power Steering system. Find cause and correct.

With Engine Cold

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level.
3. Level should be between "FULL COLD" mark and bottom of dipstick.



4. If fluid level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of automatic transmission fluid (ATF), type "F", Dexron, or Dexron II, thru fill cap opening, to bring level up to "FULL COLD" mark on dipstick - Do not overfill.
5. If fluid is not visible in reservoir, a leak exists in the Power Steering system. Find cause and correct.

Filling and Bleeding Power Steering System

IMPORTANT: Power Steering system must be filled exactly as explained, following, to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause Power Steering system to become spongy, which may result in poor boat control.

1. Position drive unit so that it is straight back. Remove shipping cap from Power Steering pump and check fluid level with dipstick attached to fill cap (provided). Add automatic transmission fluid (ATF), Dexron or Dexron II as required, to bring level up to "FULL-COLD" mark on dipstick.

IMPORTANT: Use only automatic transmission fluid (ATF), Dexron or Dexron II in Power Steering System.

2. Turn steering wheel back-and-forth to end of travel in each direction several times; then, recheck fluid level and add fluid, if necessary.
3. Install vented fill cap.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump or pump impeller may be damaged and subsequent overheating damage to engine may result.

4. Start engine and run at fast idle (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back-and-forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse; then, check fluid level and add fluid, as required, to bring level up to "FULL-HOT" mark on dipstick. Do not overfill. Reinstall fill cap securely.

IMPORTANT: Drive unit must be positioned straight back and Power Steering fluid must be hot to accurately check fluid level.

6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

Maintaining Closed Cooling Coolant Level

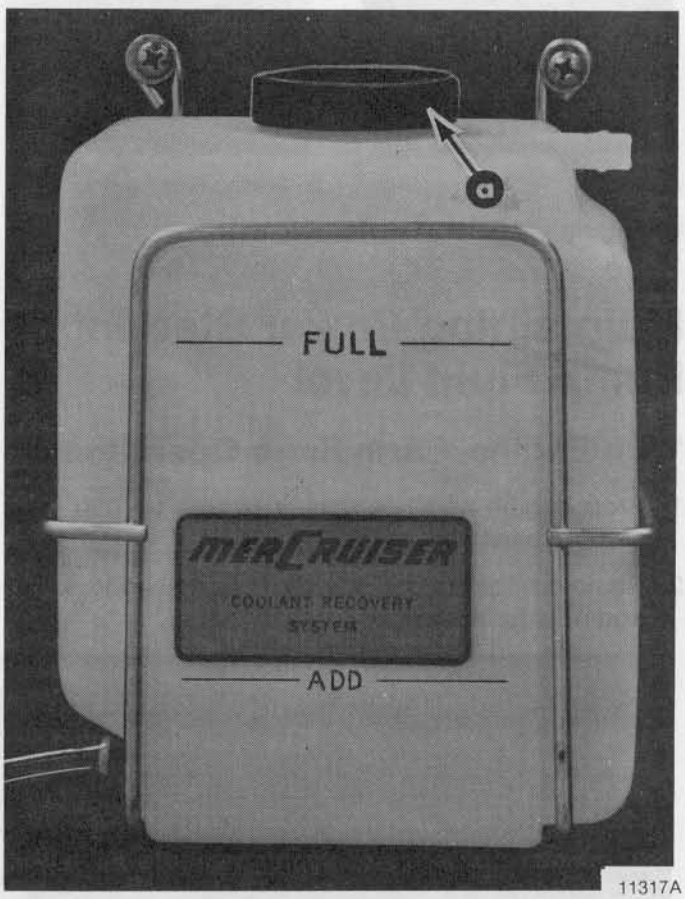
⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly; then, push down and turn cap all-the way off.

1. Coolant level in heat exchanger should be within 1 in. (25mm) from bottom of filler neck.

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stop on filler neck.

2. Coolant level should be between the "ADD-FULL" marks on coolant recovery reservoir with the engine at normal operating temperature.



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a - Filler Cap

Flushing Cooling System

If engine is operated in salty, polluted, or mineral-laden water, flush cooling system (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Thoroughly flush cooling system prior to storage.

IMPORTANT: If cooling system is to be flushed with boat in the water, water inlet valve (if so equipped) must be closed or water inlet hose must be disconnected and plugged, to prevent water from flowing into boat and cooling system. If a valve is to be installed for this purpose, valve used must have an internal cross-sectional area equal to or greater than water inlet hose to prevent restricting water flow during normal operation. A 1-1/4 in. (32mm) or larger brass ball valve or gate valve is recommended.

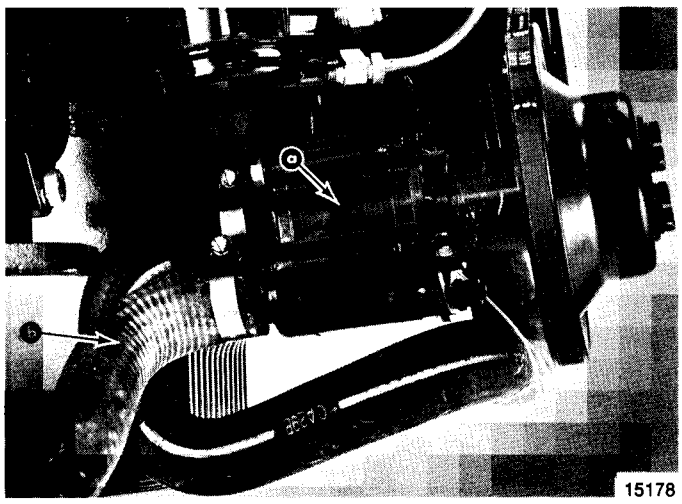
Belt Driven Seawater Pickup Pump

All V-8 engine equipped with an engine mounted, belt driven seawater pickup pump, follow these instructions.

⚠CAUTION

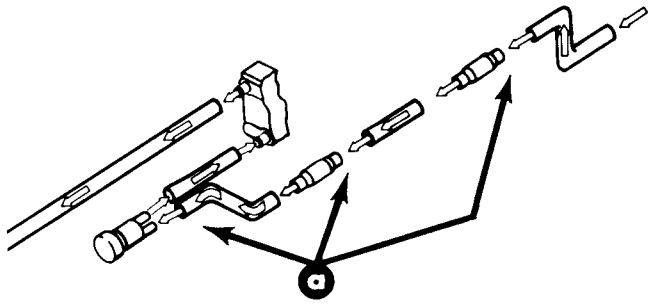
Belt Driven Pump Models Equipped with MerCruiser I or Alpha One Stern Drives: In addition to pump on engine, cooling water also must be supplied to seawater pickup holes in gear housing or overheating and subsequent damage to drive unit will result.

1. Disconnect seawater inlet hose from appropriate location.



a - Seawater Pickup Pump
b - Seawater Inlet Hose - Remove

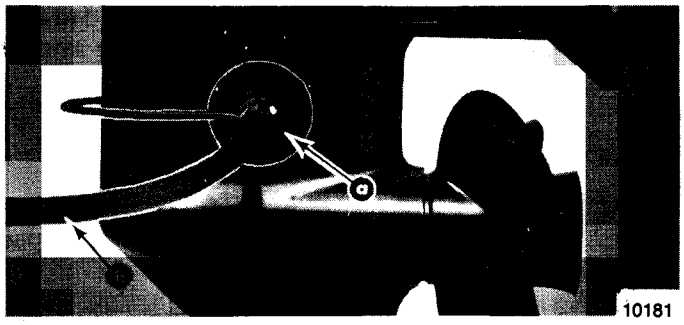
V-8 Engine Except MCM 370TRS/400TRS and 454 C.I.D. Cyclone Engines



a - Disconnect Hose at Appropriate Location - Cooling Water Must Flow thru Cooler(s), If Engine Is So Equipped

MCM 370TRS/400TRS/ and Hi-Performance 454 C.I.D. Engines

2. **IMPORTANT: V-8 engines, equipped with MerCruiser I or Alpha One Stern Drives, which will be flushed with boat out-of-water, use Flush Test Device 73971A2 to supply cooling water to drive unit.**



a - Flush Device
b - Garden Hose

Flush Test Device 73971A2 Installed on MerCruiser I/ Alpha One Stern Drive

Using appropriate connector, connect city water tap to pump inlet connection and partially open water tap (approximately 1/2 maximum capacity). Do not use full city water pressure.

⚠WARNING

When flushing cooling system with boat out of the water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that propeller be removed.

⚠CAUTION

DO NOT run engine above 1500 RPM, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

3. Place the remote control lever in neutral position and start engine. Operate engine at idle speed in neutral gear for 10 minutes or until discharge water is clear; then, stop engine.

⚠CAUTION
Watch temperature gauge at dash to ensure that engine does not overheat.

4. Shut off water tap. Remove flushing connector from pump inlet and reconnect water inlet hose. Be sure to tighten hose clamp securely.

IMPORTANT: If boat is in the water, do not open water inlet valve until engine is to be restarted, to prevent contaminated water from flowing back into engine. If boat is not fitted with a valve, leave water inlet hose disconnected and plugged.

MCM-I/Alpha One Stern Drive Unit Seawater Pickup Pump

⚠CAUTION
DO NOT run engine above 1500 RPM when flushing, as suction created by seawater pickup pump in drive unit may collapse garden hose and cause engine and/or drive unit to overheat.

BOAT OUT-OF-WATER

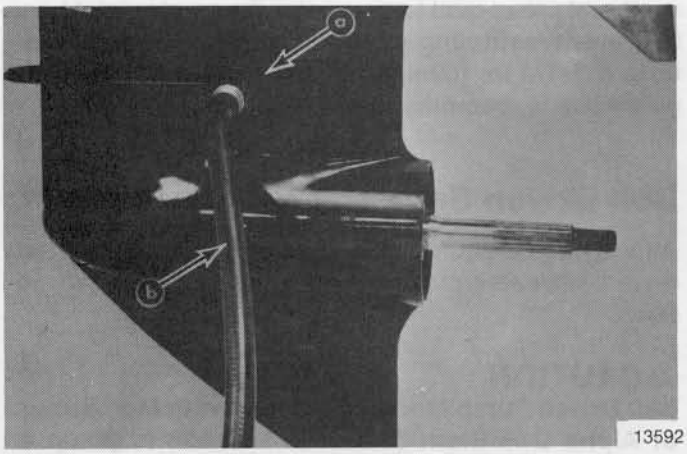
1. Install Flush-Test-Device 73971A2 over water pick-up holes in gear housing. Attach a garden hose between the device and water tap.
2. Partially open water tap (approximately 1/2 maximum capacity). DO NOT use full city water pressure.

⚠WARNING
When flushing cooling system, be certain that area in vicinity of propeller is clean and that no person(s) is nearby. As a precautionary measure, it is recommended that propeller be removed.

3. Place remote control in neutral, idle speed position, and start engine.
4. Operate engine at idle speed in neutral for 10 minutes, or until discharge water is clear; then, stop engine.
5. Shut off water tap. Remove Flush-Test-Device and garden hose.

BOAT IN-THE-WATER

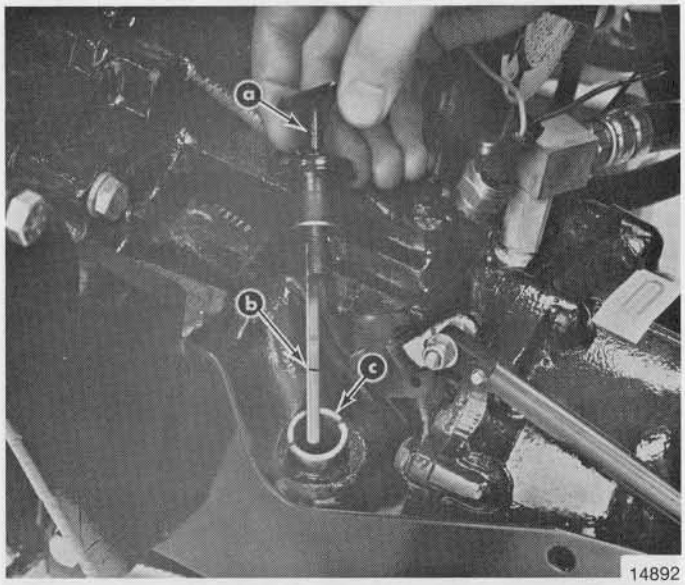
1. Raise drive unit to full "Up" position.
2. Install Flush-Test-Device 73971A2 over water pick-up holes in gear housing. Attach a garden hose between the device and water tap.
3. Lower drive unit to full "In" position.
4. Follow Steps 2 thru 4 under "Boat Out-of-Water".
5. Shut-off water tap.
6. Raise drive unit to full "Up" position - Remove Flush-Test-Device and garden hose.



a - Flush Test Device 73971A2
b - Garden Hose

Maintaining Transmission Fluid Level

1. Remove dipstick. Check to ensure that fluid is indicated on dipstick. Fluid level may be somewhat over the full mark, as some of the fluid from transmission fluid cooler and hoses may have drained back into transmission. If level is low, add automatic transmission fluid (ATF) until level comes up to full mark on dipstick.



a - Dipstick
b - Full Mark
c - Dipstick Tube

Checking Transmission Fluid Level

IMPORTANT: To accurately check fluid level, engine MUST BE run at 1500 RPM for 2 minutes immediately prior to checking level.

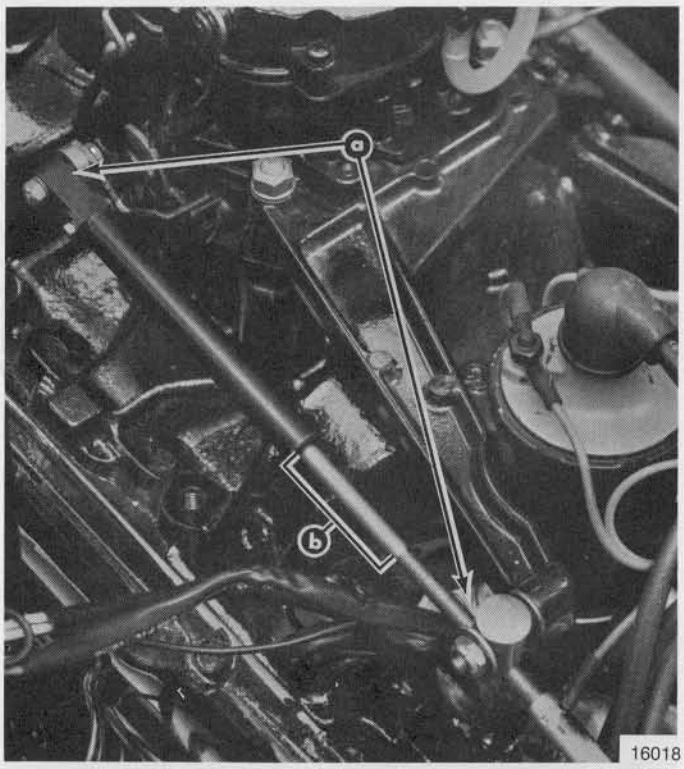
2. Start engine and run at 1500 RPM for 2 minutes to fill all hydraulic circuits.

IMPORTANT: Be sure to push dipstick all-the-way down into dipstick tube when checking fluid level.

3. Stop engine and QUICKLY check fluid level. Add automatic transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick.
5. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

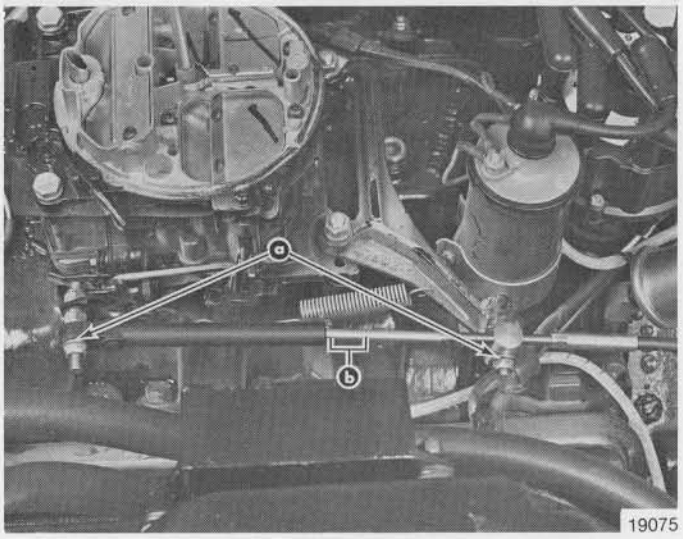
Lubrication

Throttle Cable



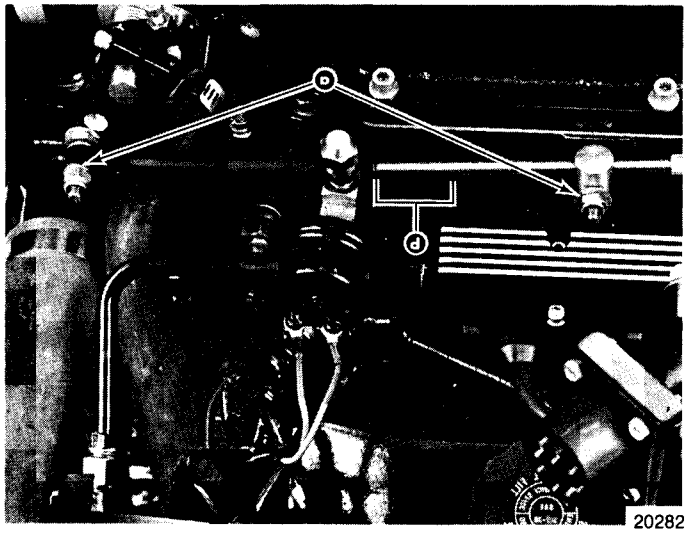
a - SAE 30W Engine Oil
b - 2-4-C Marine Lubricant

Typical 2-Barrel Carburetor



a - SAE 30W Engine Oil
b - 2-4-C Marine Lubricant

Typical 4-Barrel Carburetor



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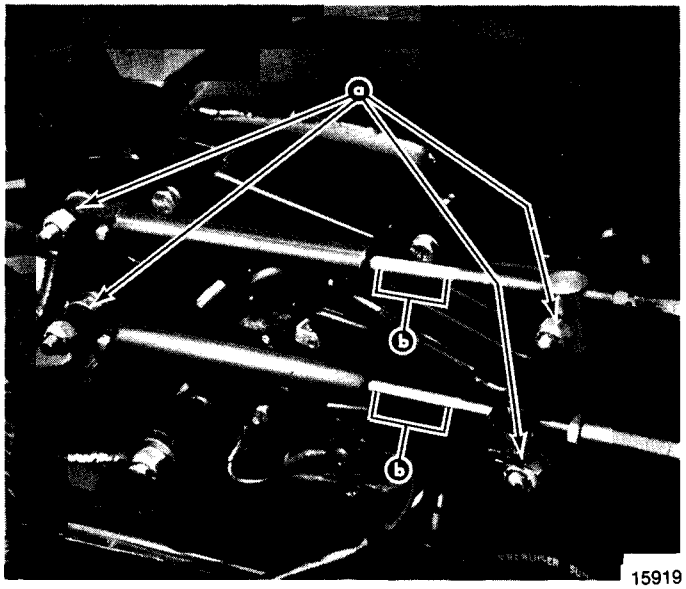
a - SAE 30W Engine Oil
b - 2-4-C Marine Lubricant

EFI

Shift Cable



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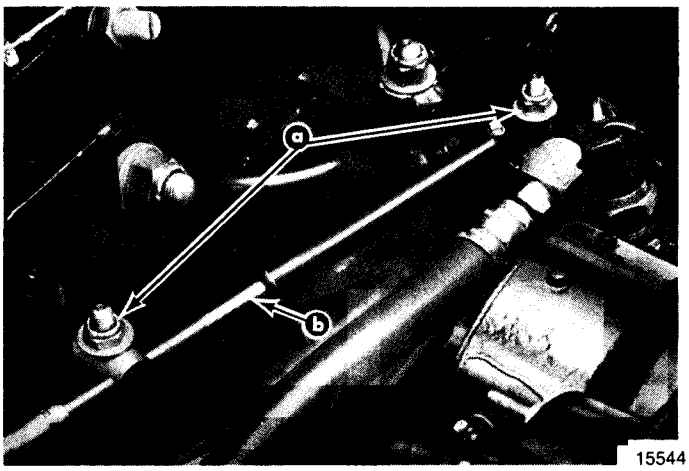
a - SAE 30W Engine Oil
b - 2-4-C Marine Lubricant

MCM Models with MR, Alpha One Drives, Bravo I Drive (Without Neutral Switch)



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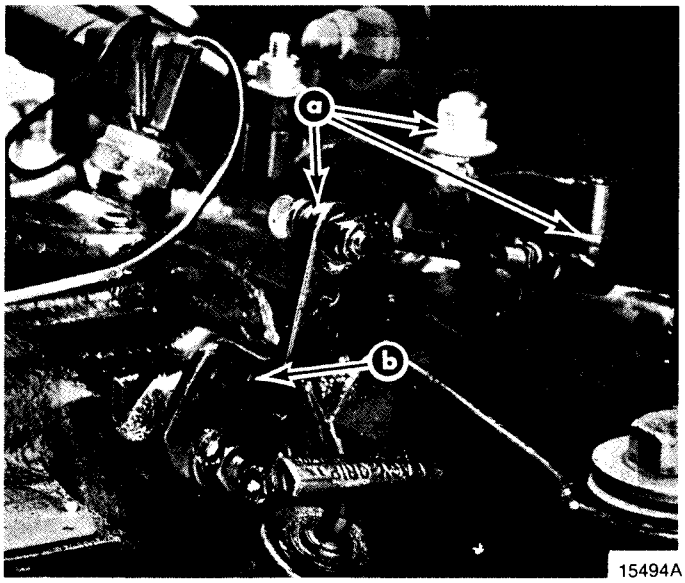
a - SAE 30W Engine Oil
b - 2-4-C Marine Lubricant

MCM Models with Transmissions (TR/TRS)



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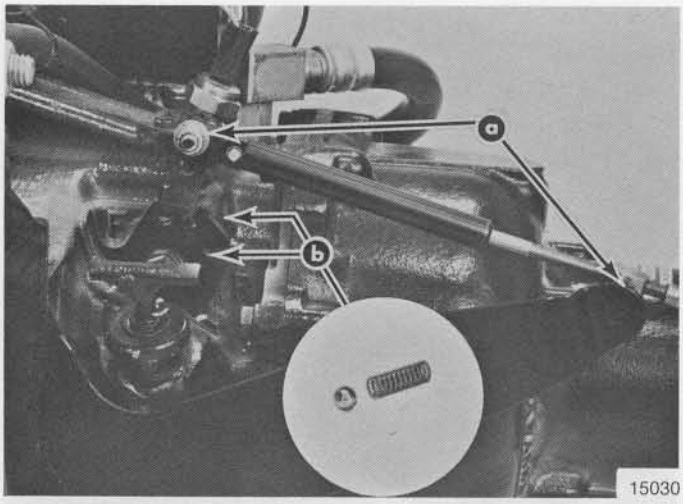
a - SAE 30W Engine Oil
b - 2-4-C Marine Lubricant

MCM Models with Transmissions (TR/TRS)

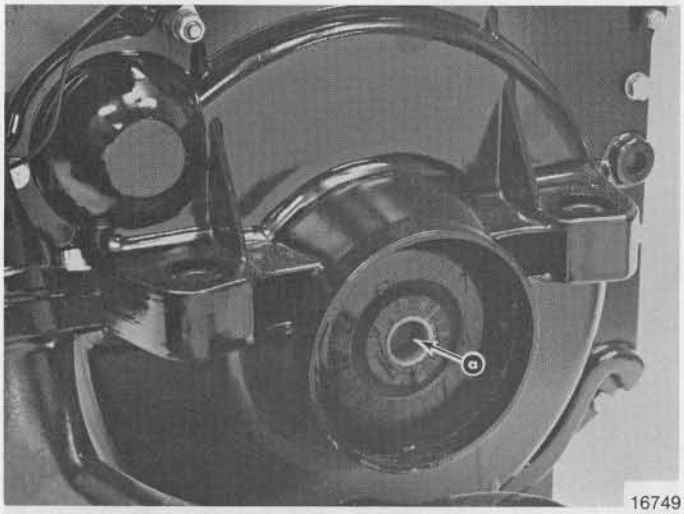


a - SAE 30W Engine Oil
b - 2-4-C Marine Lubricant

MIE Models (Typical) Shift Cable and Transmission Linkage

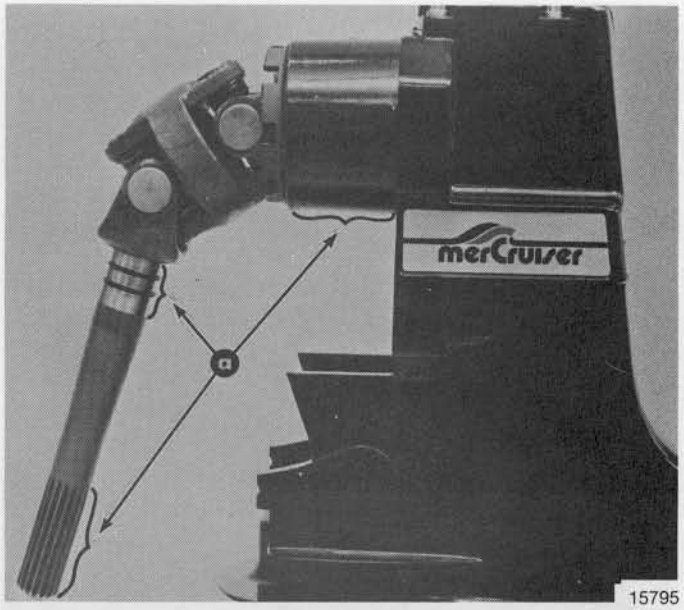
Engine Coupler/U-Joint Shaft Splines

NOTE: Refer to MerCruiser Stern Service Manual, for stern drive unit removal and installation.



a - 2-4-C Marine Lubricant

MCM Models with Alpha One Drive

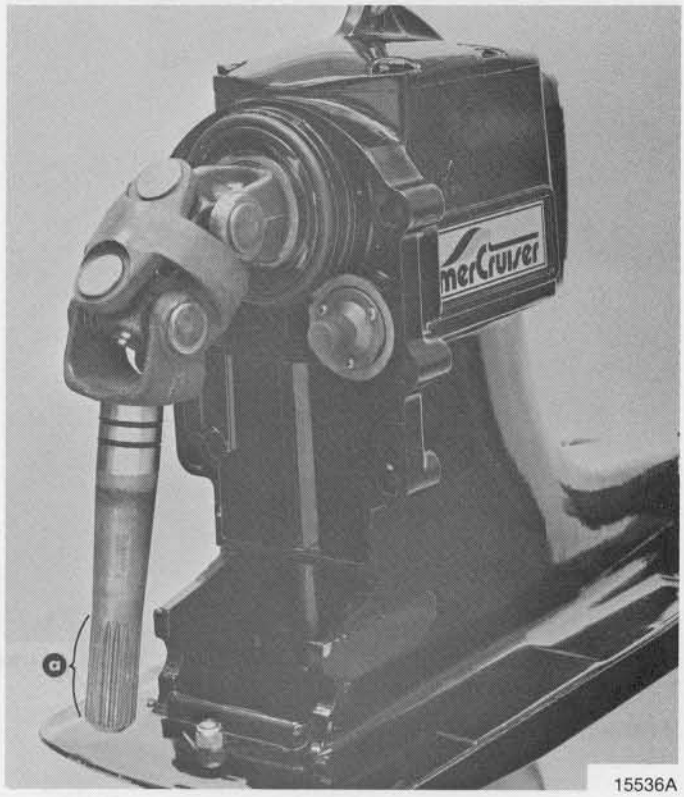


a - 2-4-C Marine Lubricant

Alpha One Drive

U-Joint Shaft Splines (Stern Drive Models with Borg-Warner Transmission)

NOTE: Refer to appropriate MerCruiser Stern Drive Service Manual, for stern drive unit removal and installation.



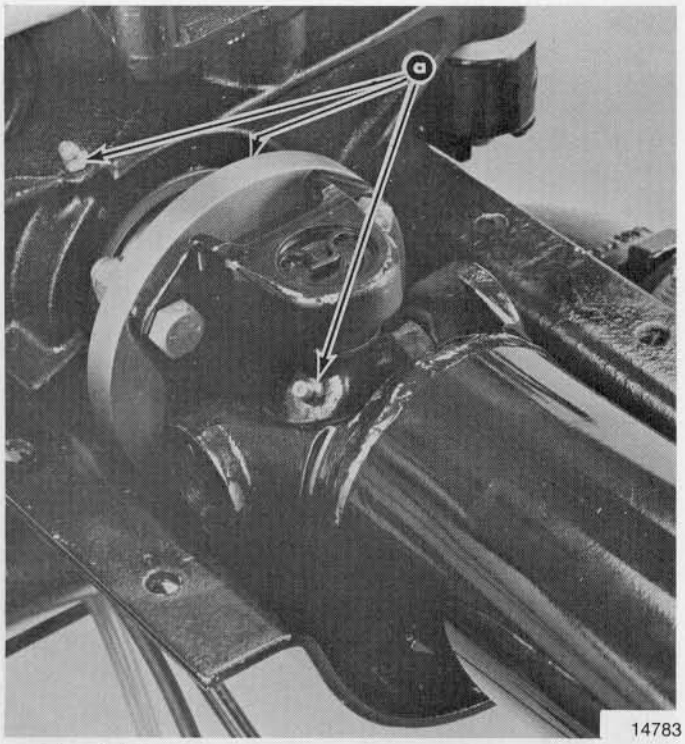
a - 2-4-C Marine Lubricant

TR/TRS Stern Drive Unit

a - 2-4-C Marine Lubricant

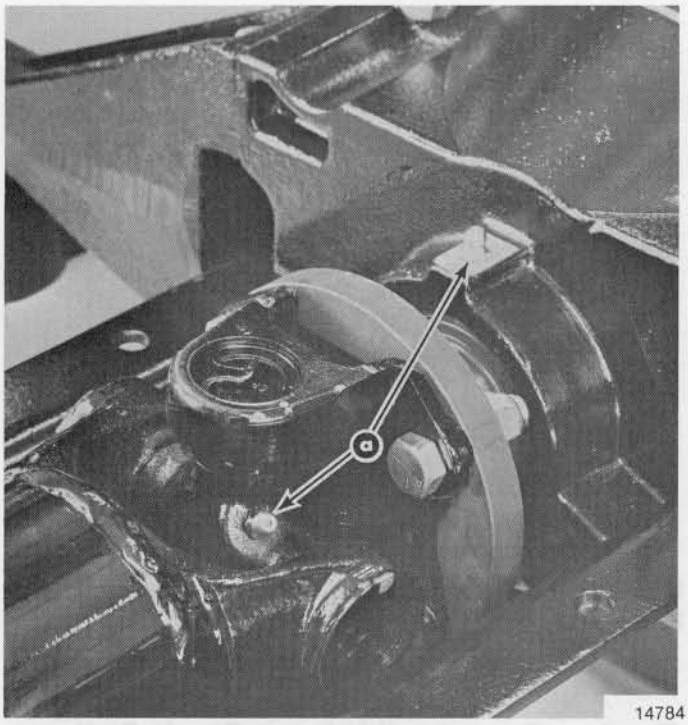
Bravo One Drive

Drive Shaft Extension Models (MCM 305, 350 CID)



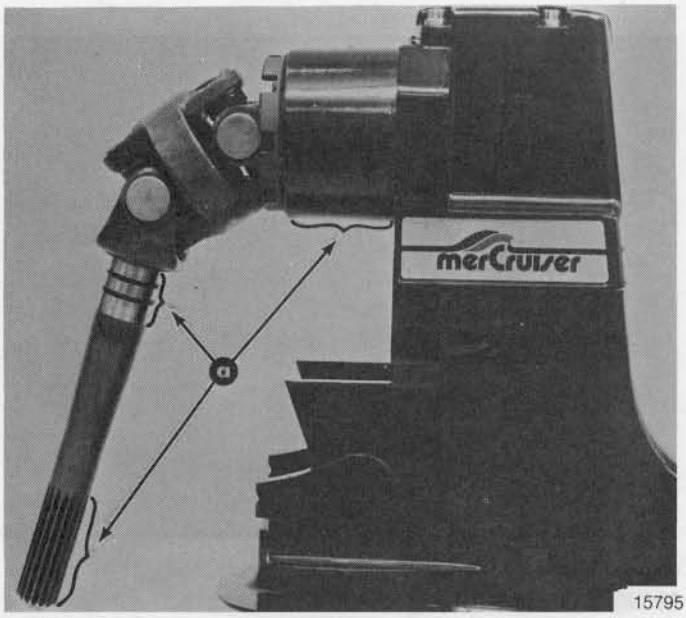
a - 2-4-C Lubricant

Transom End



a - 2-4-C Marine Lubricant

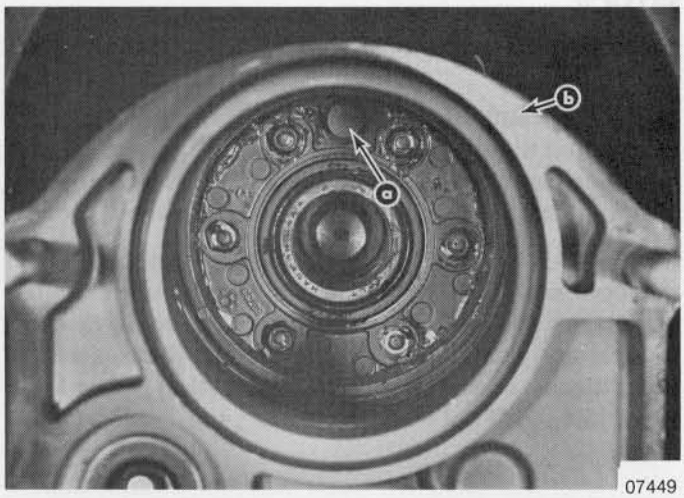
Engine End



a - 2-4-C Marine Lubricant

MCM I/Alpha One Stern Drive U-Joint

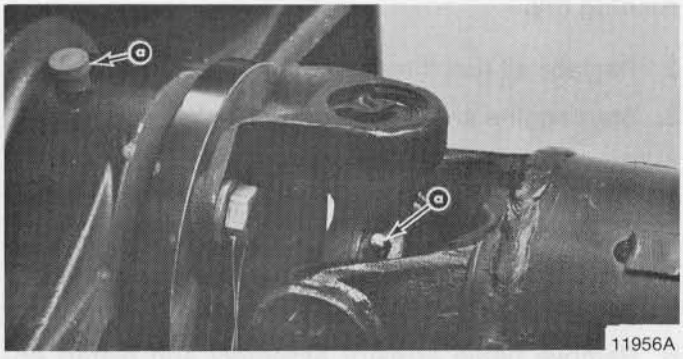
Staggered Engine All Models



07449

a - 2-4-C Marine Lubricant
b - Bell Housing

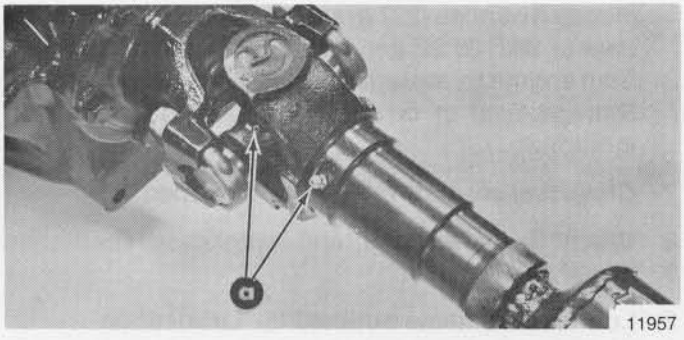
Tailstock Assembly



11956A

a - 2-4-C Marine Lubricant

Tailstock and Driveshaft (Transom End)



11957

a - 2-4-C Marine Lubricant

Driveshaft (Engine End)

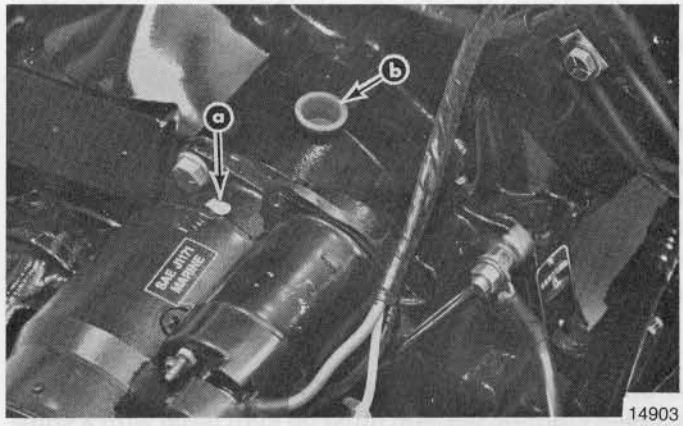
Starter Motor Lubrication

⚠WARNING

When performing the following procedure, be sure to observe the following:

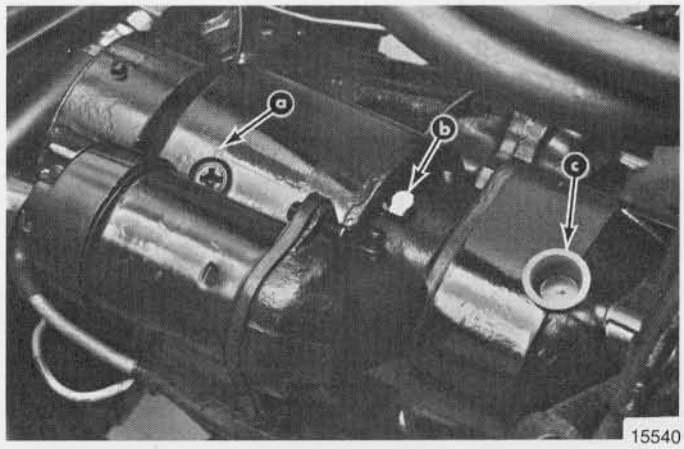
- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of a fire.**
- **Be sure to keep hands, feet and clothing clear of engine moving parts.**
- **Be sure to ground coil hi-tension wire to block. Failure to ground coil wire may cause damage to ignition coil, in addition to being a safety hazard.**

MCM 330 B/W, and MIE 230, 260, 5.0 Litre, 5.7 Litre, 340, 7.4 Litre and 5.7 Ski



14903

MCM 300 Tempest TRS, 370/400 TRS, 400/440/460 Cyclone, MCM 420/575



15540

a - Remove ignition coil hi-tension wire from distributor cap tower and ground it to engine block with jumper wire. While cranking engine with starter motor, lubricate starter motor front bushing thru oil cover with Lubriplate Extra-Heavy Gear Shield or its equivalent. Reinstall coil hi-tension wire.
b - Remove plastic plug from flywheel housing. Lubricate starter motor shaft with Lubriplate Extra-Heavy Gear Shield thru hole in flywheel housing. Reinstall plastic plug.

Starter Motor Lubrication

Out-of-Season Storage

Precautions

⚠WARNING
Be careful while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF" and do not smoke or allow sources of spark and/or open flames in the area.

⚠WARNING
To prevent a potential fire hazard, be sure that engine compartment is well ventilated and that there are no gasoline vapors present during starting or fogging of engine.

⚠CAUTION
DO NOT operate engine without cooling water being supplied to seawater pickup pump, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠CAUTION
Cooling System must be completely drained for storage, or trapped water may cause freeze and/or corrosion damage to engine. If engine has been exposed to freezing temperatures, the boat should be placed in a warm area before attempting to run engine or drain cooling system.

⚠CAUTION
If engine is equipped with Closed Cooling System, Closed Cooling section must be kept filled with a solution of ethylene glycol anti-freeze and water (mixed anti-freeze manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). Seawater section, however, must be drained completely.

⚠CAUTION
A discharged battery can be damaged by freezing.

Layup

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Fill fuel tank(s) with fresh gasoline that does not contain alcohol and a sufficient amount of Quicksilver Gasoline Stabilizer and Conditioner to treat the gasoline.

IMPORTANT: If boat is to be placed in storage (with fuel containing alcohol in fuel tanks), carburetors must be run dry at idle RPM. Fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Also, refer to "Fuel Requirements"; see Table of Contents.

320 EFI Only: Drain tanks completely and add one gallon of gasoline mixed with Quicksilver 2-Cycle outboard Oil at 20:1 gasoline/oil ratio. Run engine to distribute fuel mix throughout engine EFI system without running dry.

2. Replace all fuel filters.
3. Start engine and check for fuel leaks.
4. Run engine sufficiently to bring it up to normal operating temperature; shut off engine and change oil and filter.
5. If boat has been operated in salty, polluted or mineral-laden waters, flush cooling system.
6. Remove flame arrestor assembly and restart engine. While operating engine at fast idle (1000-1500 RPM), fog internal surfaces of induction system and combustion chambers by squirting approximately 8 ounces (227 grams) of Quicksilver Storage Seal or SAE 20 SE engine oil into carburetor bores. Stall engine by squirting last 2 ounces (57 grams) of Storage Seal or oil rapidly into carburetor. Turn ignition to "OFF".
7. Close fuel shut off valve, if so equipped.
8. Clean flame arrestor and crankcase ventilation hoses and reinstall.
9. Lubricate all items outlined in "Lubrication".
10. Drain cooling system.
11. Closed Cooling System Models, test coolant to ensure that it will withstand lowest temperature expected during storage.
12. Service batteries.
13. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion and Rust Preventive Type II or wipe down with Quicksilver Storage Seal or SAE 20 SE engine oil.
14. For Stern Drive Unit Refer to "Stern Drive Manual.

Recommissioning

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Check that all cooling system hoses are connected and tight and all petcocks and drain plugs are in and tight.
2. Inspect all drive belts.
3. Check engine belts.
4. Perform all lubrication and maintenance specified for completion "At Least Once Each Year" in maintenance chart, except items which were performed at time of engine layup.
5. Install Stern Drive unit. (Refer to Stern Drive Manual).

⚠CAUTION
When installing battery (in next step), be sure to connect negative (grounded) battery cable to negative (-) battery terminal and positive battery cable to positive (+) terminal. If battery cables are reversed, damage to electrical system WILL result.

6. Install fully-charged battery. Clean battery cable clamps and terminals and reconnect cables. Be sure to tighten clamps securely. Apply a thin coat of petroleum base grease to clamps and terminals to help retard corrosion.
7. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
8. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
9. Check fuel pump sight tube.
10. Check steering system and shift and throttle control for proper operation.

TROUBLESHOOTING

1 C

CAUSE	SPECIA
1. Moisture on ignition components	1. Distributor cap or spa
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	
4. Shift interruptor switch	5. Disconnect tachom
5. Shorted tachometer	
6. Ignition timing	7. Fouled, burned, cr
7. Spark plugs	8. Faulty insulation,
8. Spark plug wires	
9. Cracked or dirty distributor cap	10. Check compone
10. Faulty ignition components	11. Synchronizers m (parallel circuit)
11. Engine synchronizer (if equipped) hooked up in series on ignition wire (dual engines only)	

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NOTICE
Refer to "Precautions", BEFORE proceeding with troubleshooting.

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Precautions

⚠WARNING
Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING
Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING
Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING
Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠CAUTION
DO NOT operate engine without water being supplied to seawater pickup pump on engine, or pump impeller may be damaged and subsequent overheating damage to engine may result. Engine may be operated with boat out-of water, if instructions, under "Running Engine with Boat Out-of-the-Water", following are completed.

⚠WARNING
When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠CAUTION
DO NOT run engine above 1500 RPM, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

⚠WARNING
Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE.

⚠WARNING
DO NOT leave helm unattended while performing idle speed adjustment.

Used Spark Plug Analysis

Use the following illustrations for determining serviceability of spark plug. Spark plug condition also can suggest a variety of possible engine malfunctions and, therefore, can indicate needed engine repairs. When old plugs are replaced, replace entire set. Perform plug service only on those plugs suitable for additional service, using the following procedures:

A. Remove any oil deposits with solvent and dry plugs thoroughly.

B. Open electrode gap wide enough to permit cleaning and filling.

C. Remove combustion deposits from firing end of spark plug with a plug cleaner. Blow off with compressed air to remove abrasives.

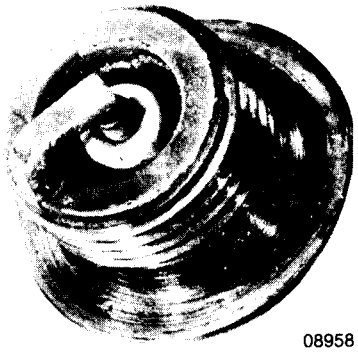
D. File electrode surfaces to restore clean, sharp edges. Again remove fillings with compressed air.

E. Reset gap to specifications by bending only side electrode with proper tool.

Spark Plug Analysis

NORMAL CONDITION

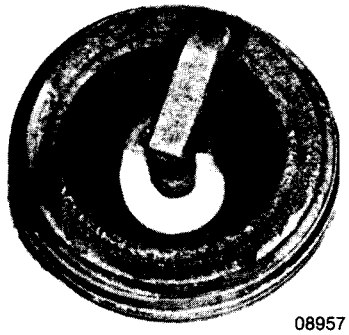
Few deposits are present and probably will be light tan or gray in color. This plug shows that plug heat range is compatible with engine, and engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file and regap), this plug can be reinstalled with good results.



08958

CHIPPED INSULATOR

Chipped insulator usually results from careless plug regapping. Under certain conditions, severe detonation also can split insulator firing ends. Plug must be replaced.



08957

WET FOULING (OIL DEPOSITS)

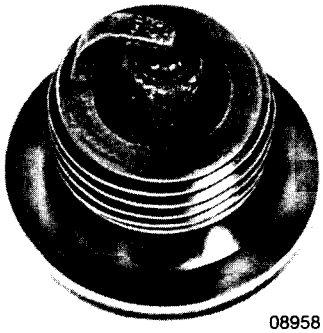
Plug becomes shorted by excessive oil entering combustion chamber, usually in engines with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

IMPORTANT: New engines or recently overhauled engines may wet foul plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file and regap) and reinstalled.

08958

COLD FOULING

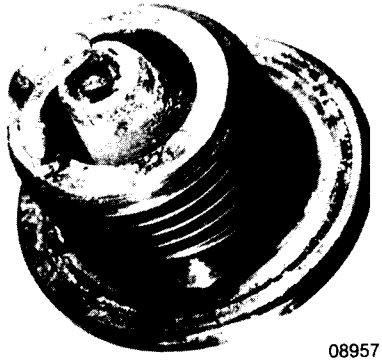
Dry, black deposits indicate rich fuel mixture or weak ignition. Clogged flame arrestor, flooding carburetor, sticky choke or weak ignition components all are probable causes. If, however, only one or two plugs in set are fouled, check for sticking valves or bad ignition leads. After correcting cause, service (clean, file and regap) plugs and reinstall.



08958

OVERHEATING

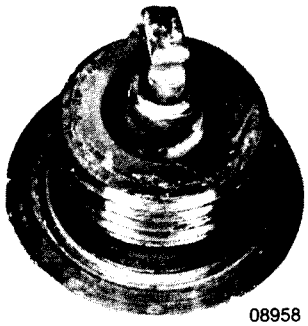
Insulator is dull white or gray and appears blistered. Electrodes are eroded and there is an absence of deposits. Check that correct plug heat range is being used. Also check for over-advanced ignition timing, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold or sticking valves. Replace spark plugs.



08957

HIGH SPEED GLAZING

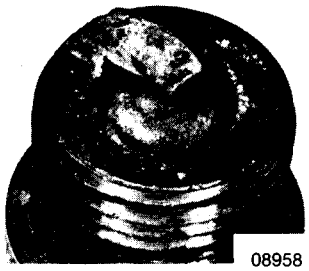
Insulator has yellowish, varnish-like color, indicating that temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace plugs. If condition re-occurs, use colder heat range plug and service plugs more frequently.



08958

SCAVENGER DEPOSITS

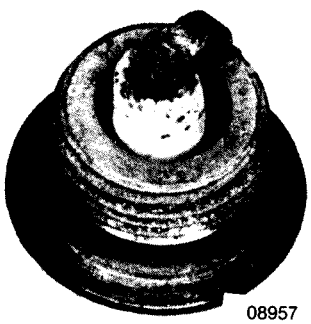
Powdery white or yellow deposits are built up on shell, insulator and electrodes. This is a normal appearance with certain branded fuels. Accumulation on ground electrode and shell areas may be unusually heavy, but may be easily chipped off. Plugs can be serviced (clean, file and regap) and reinstalled.



08958

PRE-IGNITION DAMAGE

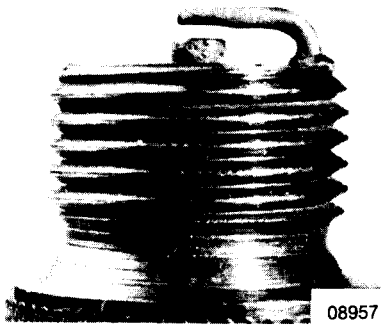
Pre-ignition damage is caused by excessive high temperatures. Center electrode melts first, followed by ground electrode. Normally, insulators are white but may be dirty if plug has been misfiring. Check for correct plug heat range, advanced ignition timing, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold or lack of lubrication.



08957

REVERSED COIL POLARITY

Concave erosion of ground electrode is an indication of reversed polarity. Center electrode will show only normal wear. Engine will misfire and idle rough. To correct, reverse primary coil leads. Replace spark plugs.



08957

SPLASHED DEPOSITS

Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon installation of new plugs, deposits loosen from top of piston and head and are thrown against hot insulator. Clean and service plugs and reinstall.

08958

MECHANICAL DAMAGE

Mechanical damage to spark plug firing end is caused by foreign object in combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, intake manifold and exhaust manifold to prevent further damage.

08957

IMPORTANT: When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.

Poor Boat Performance and/ or Poor Maneuverability

SYMPTOM	CAUSE
1. Bow too low	1. A. Improper drive unit trim angle B. Improper weight distribution C. Boat is underpowered D. Permanent or power hook in boat bottom E. False bottom full of water F. Improperly adjusted trim tabs (after planes)
2. Bow too high	2. A. Improper drive unit trim angle B. Propeller pitch too great C. Dirty boat bottom (marine growth) D. Poor running engine E. Improper weight distribution F. Rocker in boat bottom G. False bottom full of water H. Improperly adjusted trim tabs (after planes)
3. Propeller ventilating	3. A. Drive unit installed too high on transom B. Dirty or rough boat bottom C. Damaged propeller; pitch too small; diameter too small D. Keel located too close to propeller or too deep in the water E. Water pick-up or accessories located too close to propeller F. Hook in boat bottom G. Propeller plugged up with weeds

Improper Full Throttle Engine RPM

RPM TOO HIGH

CAUSE	SPECIAL INFORMATION
1. Propeller	1. Damaged; pitch too low; diameter too small; propeller hub slipping
2. Boat	2. Water pick-up or accessories mounted too close to propeller (ventilation); keel located too close to propeller and/or too deep in the water (ventilation). Drive installed too high on transom; wrong gear ratio.
3. Operation	3. Unit trimmed out too far.
4. Engine coupler slipping	

RPM TOO LOW

CAUSE	SPECIAL INFORMATION
1. Propeller	1. Damaged; pitch too great; diameter too great.
2. Boat	2. Dirty or damaged bottom; permanent or power hook in bottom; false bottom full of water. Drive installed too low on transom; wrong gear ratio.
3. Operation	3. Unit trimmed in too far

Engine Cranks Over But Will Not Start or Starts Hard

IMPORTANT INFORMATION

1. First, determine which engine system is causing the problem. To make an engine run, basic components - fuel, spark (ignition), and compression are required. If all three components are present, the engine should run. If any one of the three are missing, weak, or arriving at the wrong time the engine will not run.
2. Determine if there is fuel present by looking down the carburetor venturi while actuating throttle. There should be a stream of fuel coming out of the accelerator pump nozzles if the carburetor has fuel.
3. Check ignition system operation. Remove coil wire from tower on distributor cap. Hold coil wire near ground and check for spark while cranking engine over. Repeat procedure with spark plug wires. If there is spark at the spark plug wires, remove the spark lugs and make sure the plugs are correct type and heat range, and not fouled or burned.
4. Run a compression check on engine to make sure the engine is mechanically OK.

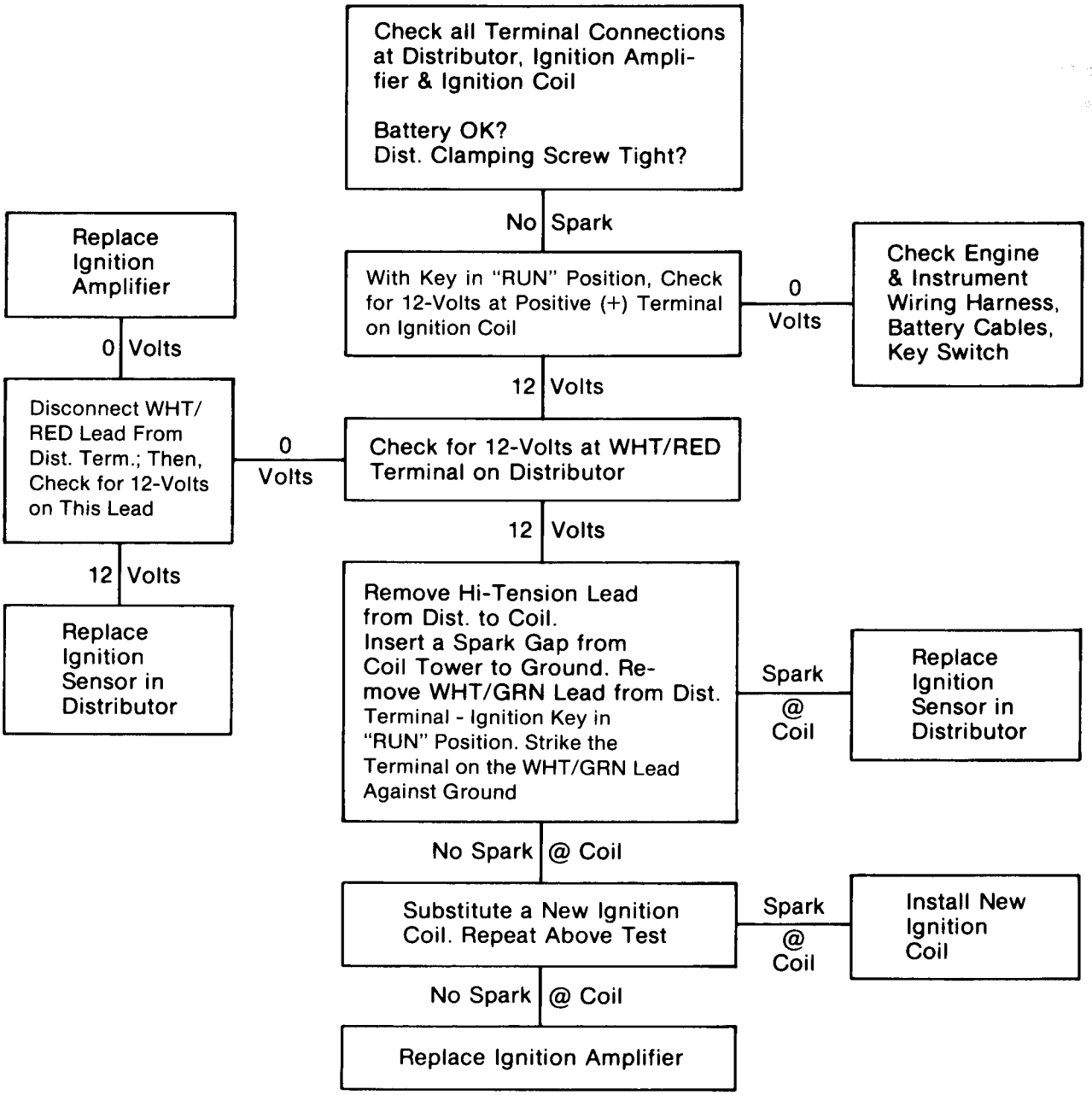
CONVENTIONAL IGNITION (NO SPARK)

CAUSE	SPECIAL INFORMATION
1. Moisture on ignition components	1. Distributor cap or spark plug leads arcing
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	3. May run in start position and lose spark in the run position.
4. Shift interruptor switch (I/Alpha One Models Only)	
5. Shorted tachometer	5. Disconnect tachometer and try again.
6. Ignition timing	6. May crank over hard, backfire, or try to run backwards
7. Faulty ignition resistor wire or bypass wire	
8. Ignition points improperly gapped, burned or dirty	
9. Spark plugs	9. Fouled, burned, cracked porcelain
10. Spark plug wires	10. Faulty insulation, broken wires
11. Cracked or dirty distributor cap or rotor	
12. Coil	
13. Condenser	

THUNDERBOLT IV (HEI) IGNITION (NO SPARK)

CAUSE	SPECIAL INFORMATION
1. Moisture on ignition components	1. Distributor cap or spark plug wires arcing
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	
4. Shift interruptor switch (I/Alpha One Models Only)	
5. Shorted tachometer	5. Disconnect tachometer and try again
6. Ignition timing	
7. Spark plugs	7. Fouled, burned, cracked porcelain
8. Spark plug wires	8. Faulty insulation, broken wires
9. Cracked or dirty distributor cap	
10. Faulty ignition components	10. Check components
11. Engine synchronizer (if equipped) hooked up in series on purple ignition wire (dual engines only)	11. Synchronizers must be hooked up directly at coil terminal (parallel circuit)

THUNDERBOLT IV (HEI) IGNITION TEST



FUEL SYSTEM RICH

CAUSE	SPECIAL INFORMATION
1. Warm engine carburetor percolation	1. Fuel boils out of float bowl when shut off and warm. Floods intake manifold.
2. Clogged flame arrestor	
3. Automatic choke not opening	
4. Float adjustment	
5. Float leaks or is saturated with fuel	
6. Needle and seat leaking	
7. Carburetor gaskets leaking	
8. Excessive fuel pump pressure	8. Unseats needle and seat
9. Cracked or porous carburetor body	

FUEL SYSTEM LEAN

CAUSE	SPECIAL INFORMATION
1. Empty fuel tank	
2. Fuel shut off valve closed (if equipped)	
3. Anti-siphon valve stuck closed (if equipped)	
4. Vapor lock	4. Engine will not start after warm engine shut down
5. Automatic choke	5. Stuck open, wrong adjustment
6. Fuel tank vent plugged	6. Engine will start initially. After a short time of running, engine will stall and will not restart for a period of time. Can varify it is a vent problem by running engine with filler cap loose. Fill cap will act as a vent.
7. Air leak on suction side of fuel system	7. Sucks air into fuel system reducing fuel volume
8. Plugged or pinched fuel line	
9. Fuel pump	9. Low pump pressure

MISCELLANEOUS

CAUSE	SPECIAL INFORMATION
1. Low grade or stale fuel	
2. Water in fuel	
3. Vacuum leak	
4. Low compression	4. Worn valves, rings, cylinder, or head gasket
5. Valve timing incorrect	5. Timing chain or gears jumped or improperly installed

ENGINE WILL NOT CRANK OVER

CAUSE	SPECIAL INFORMATION
1. Control lever not in neutral position	
2. Battery charge low; damaged wiring; loose electrical connections	
3. Blown fuse at starter motor	3. Early models with red wire going to fuse on starter terminal
4. Circuit breaker tripped	
5. Ignition switch	
6. Slave solenoid	
7. Faulty neutral start safety switch	7. Open circuit
8. Starter solenoid	
9. Starter motor	

CHARGING SYSTEM INOPERATIVE

CAUSE	SPECIAL INFORMATION
1. Loose or broken drive belt	
2. Engine RPM too low on initial start	2. Rev engine to 1500 RPM
3. Loose or corroded electrical connections	
4. Faulty ammeter or battery gauge	4. Best way to test is to replace gauge
5. Battery will not accept charge	5. Low electrolyte, failed battery
6. Faulty alternator or regulator	
7. Failed fuse (if so equipped)	7. Fuse located on starter terminal stud. Orange output wire from alternator connects to fuse.
8. Refer to "Section 4, Part C" for complete "Charging System" troubleshooting procedures.	

NOISY ALTERNATOR

CAUSE	SPECIAL INFORMATION
1. Loose mounting bolts	
2. Drive belt	2. Worn, frayed, loose
3. Loose drive pulley	
4. Worn or dirty bearings	
5. Faulty diode trio or stator	

INSTRUMENTATION MALFUNCTION

CAUSE	SPECIAL INFORMATION
1. Faulty wiring, loose or corroded terminals	
2. Bad key switch	2. Test, as outlined in "Section 4 Part D"
3. Faulty gauge	3. Test, as outlined in "Section 4 Part D"
4. Faulty sender	4. Test, as outlined in "Section 4 Part D"

RADIO NOISE

CAUSE	SPECIAL INFORMATION
1. A "popping" noise that will increase with engine RPM. Noise will stop as soon as engine is turned off.	1. Ignition System - wrong spark plugs; cracked distributor cap; cracked coil tower; leaking spark plug wires; moisture on ignition components.
2. "High pitched whine" in the radio	2. Alternator - poor brush contact on the slip rings
3. A "hissing or crackling" noise when instruments are jarred with ignition on	3. Instrumentation - loose connections, or antennae wire routed too close to instruments
4. Varying unexplained noises	4. Accessories - bilge pump, bilge blower; fish finder, depth locator; cabin heater motor, etc. Disconnect one at a time until noise disappears.

POOR FUEL ECONOMY

CAUSE	SPECIAL INFORMATION
1. Fuel leaks	
2. Operator habits	2. Prolonged idling; slow acceleration; failure to cut back on throttle once boat is on plane; boat overloaded; uneven weight distribution
3. Engine laboring	3. Bent, damaged, or wrong propeller. Water test boat for proper operating RPM at WOT.
4. Clogged flame arrestor	
5. Engine compartments sealed too tight	
6. Boat bottom	6. Dirty (marine growth), hook, rocker
7. Carburetor	7. Idle mixture settings, accelerator pump adjustment, linkage binding, choke adjustment, carburetor flooding over, main fuel jets
8. Improper fuel	
9. Crankcase ventilation system not working	
10. Engine needs tune-up	
11. Engine running too cold or too hot	
12. Plugged or restricted exhaust	
13. Engine	13. Low compression

CARBURETOR MALFUNCTIONS

SYMPTOM	CAUSE
1. Flooding	1. A. Needle and seat B. Float adjustment C. Saturated float D. Gaskets leaking E. Cracked fuel bowl F. Fuel percolation G. Automatic choke
2. Rough idle	2. A. Idle RPM too low B. Idle mixture screws C. Idle passages dirty D. Throttle valves not closing E. Engine flooding F. Vacuum leak G. Throttle body heat passages plugged
3. Hesitation or acceleration flatness	3. A. Accelerator pump B. Leaking gaskets C. Automatic choke D. Power piston or power valve E. Throttle valves F. Throttle body heat passages plugged G. Main metering jets H. Float adjustment I. Secondary air valve wind-up
4. Engine surges	4. A. Main metering jets B. Leaking gaskets C. Float adjustment D. Saturated float E. Power piston or valve F. Throttle valves
5. Low top speed or lack of power	5. A. Power piston or valve B. Float adjustment C. Main metering jets D. Leaking gaskets
6. Poor cold engine operation	6. A. Idle RPM too low B. Idle mixture screws C. Throttle valves D. Automatic choke E. Engine flooding
7. Engine stalls	7. A. Idle RPM too low B. Idle mixture screws C. Engine flooding D. Automatic choke E. Dirt in carburetor F. Accelerator pump G. Leaking gaskets
8. Hard starting	8. Refer to "Engine Starts Hard"

ENGINE RUNS POORLY AT IDLE

CAUSE	SPECIAL INFORMATION
1. Clogged flame arrestor	
2. Improper idle fuel mixture adjustment	
3. Moisture on ignition components	3. Cap or spark plug wires arcing
4. Water in fuel	
5. Low grade or stale fuel	
6. Incorrect ignition timing	
7. Automatic choke	
8. Spark plugs	8. Fouled, burned, cracked porcelain
9. Incorrect point gap, burned or pitted points	
10. Spark plug wires	10. Insulation break down, wires broken
11. Defective coil or condenser	
12. Cracked or dirty distributor cap	
13. Incorrect float level	
14. Dirty carburetor	
15. Vacuum leak	15. Leak at manifold or carburetor base
16. Incorrect fuel pump pressure	16. Too low - can't supply the carburetor Too high - unseats the needle and seat
17. Low compression	17. Also check for blown head gasket
18. Loose or worn distributor	18. Timing and/or dwell changes
19. Water leaking into cylinders	19. Head gasket, exhaust manifold, cracked head or valve seat
20. Loose or broken engine mounts	

ENGINE ACCELERATION IS POOR

CAUSE	SPECIAL INFORMATION
1. Also refer to "Poor Boat Performance"	1. See "Index"
2. Idle mixture screws	
3. Air valve spring out of adjustment	3. Rochester 4 barrel carburetor only
4. Incorrect ignition timing	
5. Incorrect distributor or amplifier advance curve	5. Refer to Section 4, Part B
6. Accelerator pump	6. Check for stream of raw fuel from accelerator pump discharge nozzle, when opening throttle with engine shut off
7. Cracked or dirty distributor cap or rotor	
8. Vacuum leak	8. Intake manifold or carburetor base
9. Spark plugs	9. Fouled, burned; wrong heat range; cracked porcelain
10. Incorrect point gap, dirty or burned points	
11. Float adjustment	
12. Dirty carburetor	
13. Low compression	

ENGINE RUNS POORLY AT HIGH RPM

CAUSE	SPECIAL INFORMATION
1. Also refer to "Poor Boat Performance"	1. See "Index"
2. Crankcase over-filled with oil	2. Check oil level with boat at rest in the water. Refer to Section 1, Part B
3. Anti-siphon valve (if equipped)	3. Restricting fuel supply
4. Plugged fuel tank vent	
5. Fuel supply	5. Refer to "Carburetor Malfunctions." (See "Index")
6. Ignition timing	
7. Low grade of fuel or water in the fuel	
8. Spark plugs	8. Fouled, burned, cracked porcelain, incorrect heat range
9. Spark plug wires	9. Poor insulation, broken wires
10. Distributor cap or rotor	10. Dirty or cracked
11. Coil	
12. Distributor	12. Points, condenser, worn cam, excessive play in shaft
13. Engine overheating	13. Refer to "Engine Over Heats" (See "Index")
14. Low compression	14. Worn valves, rings, cylinders, etc.
15. Restricted exhaust	

TROUBLESHOOTING WITH VACUUM GAUGE

READING	CAUSE
1. Steady reading betweeen 15-21 inches at idle RPM	1. Normal
2. Extremely low reading, but steady at idle RPM	2. Vacuum leak; incorrect timing; under powered boat; faulty boat bottom
3. Fluctuates between high and low at idle RPM	3. Blown head gasket between 2 adjacent cylinders
4. Fluctuates 4 or 5 inches very slowly at idle RPM	4. Carburetor needs adjustment; spark plug gap too narrow; valves are sticking
5. Fluctuates rapidly at idle, steadies as RPM is increased	5. Valve guides are worn
6. Continuously fluctuates between low and normal reading at regular intervals at idle RPM	6. Burned or leaking valve

ENGINE NOISE

IMPORTANT INFORMATION

No definite rule or test will positively determine source of engine noise; therefore, use the following information only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if noise is timed with engine speed or one-half engine speed. Noises timed with engine speed, are related to crankshaft, rods, pistons, piston pins, and flywheel. Noises timed to one-half engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe noise is confined to one particular cylinder, ground spark plug leads, one at a time. If noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to location in engine. Front to back; top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: flywheel or coupler; exhaust flappers rattling against exhaust pipe; crankshaft striking (pan, pan baffle, or dipstick tube); rocker arm striking valve cover; and loose flywheel cover. In many cases if this is found to be the problem, a complete engine tear down is not necessary.
6. When noise is isolated to a certain area and component, removal and inspection will be required. Refer to proper sections of service manual for information required for service.
7. If noise cannot be distinguished between engine or drive unit, remove drive from boat. Run a water supply directly to engine. Run engine without the drive to determine if noise is still there.

VALVE COVER AREA

LOCATION	POSSIBLE CAUSES
1. Valve cover area, timed to one-half engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders.	1. A. Rocker arm, striking valve cover B. Rocker arm out of adjustment C. Worn rocker arm D. Bent push rod E. Collapsed lifter

CYLINDER AREA

LOCATION	POSSIBLE CAUSES
1. Cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	1. A. Sticking valve B. Carbon build-up C. Connecting rod installed wrong D. Bent connecting rod E. Piston F. Piston rings G. Piston pin H. Cylinder worn

CAMSHAFT AREA

LOCATION	POSSIBLE CAUSES
1. Camshaft area, front of engine, timed to one-half engine speed	1. A. Camshaft timing sprocket or gear B. Timing chain C. Fuel pump D. Valve lifter E. Cam bearings
2. Camshaft area, center of engine, timed to one-half engine speed	2. A. Fuel pump B. Valve lifter C. Cam bearings
3. Camshaft area, rear of engine, timed to one-half engine speed	3. A. Distributor gear B. Valve lifter C. Cam bearings
4. Camshaft area, throughout engine, timed to one-half engine speed	4. A. Loss of oil pressure B. Valve lifters C. Cam bearings

CRANKSHAFT AREA

LOCATION	POSSIBLE CAUSES
1. Crankshaft area, front of engine, timed to engine speed	1. A. Crankshaft timing sprocket or gear B. Timing chain C. Main bearing D. Rod bearing
2. Crankshaft area, center of engine, timed to engine speed	2. A. Crankshaft striking pan or pan baffle B. Main bearing C. Rod bearing
3. Crankshaft area, rear of engine, timed to engine speed	3. A. Loose flywheel cover B. Loose coupler C. Loose flywheel D. Drive plate E. Main bearing F. Rod bearing
4. Crankshaft area, throughout engine, timed to engine speed	4. A. Loss of oil pressure B. Main bearings C. Rod bearings

MISCELLANEOUS

NOISE	POSSIBLE CAUSE
1. Engine spark knock	1. A. Advanced timing B. Low octane fuel C. Engine running hot D. Carbon deposits in engine
2. Popping through carburetor	2. A. Wrong ignition timing B. Carburetor set too lean C. Faulty accelerator pump D. Vacuum leak E. Valve adjustment F. Valve timing G. Burned or stuck valve
3. Hissing	3. A. Vacuum leak B. Fuel pump (hissing in sight tube) C. Leaking exhaust (manifolds or pipes) D. Loose cylinder heads E. Blown head gasket
4. Whistle	4. A. Vacuum leak B. Dry or tight bearing in an accessory
5. Sparks jumping	5. A. Leaking high tension lead B. Cracked coil tower C. Cracked distributor cap
6. Squeaks or squeals	6. A. Drive belt slipping B. Dry or tight bearing in an accessory C. Parts rubbing together
7. Rattling in exhaust pipe area	7. A. Exhaust shutters

OIL PRESSURE

NOTICE
Refer to "Section 1, Part B" for minimum oil pressure reading.

IMPORTANT INFORMATION

1. Measuring oil pressure	1. Use a good automotive oil pressure test gauge. Do not rely on the oil pressure gauge in the boat.
2. Check engine oil level with boat at rest in the water	2. Oil level should be between the "ADD" and "FULL" marks
3. Oil level in crankcase above "FULL" mark	3. May cause loss of engine RPM, oil pressure gauge flucuation, drop in oil pressure, and hydraulic valve lifter noise at high RPM
4. Oil level in crankcase below "ADD" mark	4. Low oil pressure; oil pressure gauge flucuation; internal engine noise and/or damage
5. Change in oil pressure	5. This may be a normal condition. Oil pressure may read high in the cooler times of the day, and when engine is not up to operating temperature. As the air temperature warms up and engine is running at normal operating temperature, it is normal for oil pressure to drop off slightly.
6. Low engine oil pressure at idle	6. With modern engines and engine oils, low oil pressure readings at idle does not necessarily mean there is a problem. If valve lifters do not "clatter" (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and, also, the oil will thin out somewhat from heat.
7. Low engine oil pressure at idle after running at a high RPM	7. Refer to "No. 5 and 6", preceding
8. Boats with dual engines	8. It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, etc.
9. Boats with dual stations	9. Refer to "No. 8", preceding

LOW OIL PRESSURE

NOTICE
Refer to "Section 1, Part B" for minimum oil pressure readings.

CAUSE	SPECIAL INFORMATION
1. Low oil level in crankcase	
2. Defective oil pressure gauge and/or sender	2. Verify reading with an automotive test gauge. Refer to "Section 4, Part D" for instrument testing.
3. Thin or diluted oil	3. Oil broken down; contains water or gas; wrong viscosity; engine running too hot or too cold; excessive idling in cold water (condensation)
4. Oil pump	4. Relief valve stuck open; pick-up tube restricted; worn parts in oil pump; air leak on suction side of oil pump or pick-up tube
5. Oil leak can be internal or external	5. Oil passage plugs leaking, cracked or porous cylinder block
6. Excessive bearing clearance	6. Cam bearings, main bearings, rod bearings

HIGH OIL PRESSURE

CAUSE	SPECIAL INFORMATION
1. Oil too thick	1. Wrong viscosity, oil full of sludge or tar
2. Defective oil pressure gauge and/or sender	2. Verify with an automotive test gauge **IMPORTANT: Oil pressure, slightly higher than normal, does not always indicate a problem. Tolerance stack-up in the engine, oil viscosity, and weather conditions could cause high oil pressure.**
3. Clogged or restricted oil passage	
4. Oil pump relief valve stuck closed	

EXCESSIVE OIL CONSUMPTION

CAUSE	SPECIAL INFORMATION
1. Normal consumption	1. One quart of oil consumed in 5-15 hours of operation at WOT (especially in a new or rebuilt engine) is normal
2. Oil leaks	2. Clean bilge, run engine with clean white paper on bilge floor, locate oil leak(s)
3. Oil too thin	3. Oil diluted or wrong viscosity
4. Oil level too high	
5. Drain holes in cylinder head plugged	5. Oil will flood valve guides
6. Defective valve seals	
7. Intake manifold gasket leaking	
8. Worn valve stems or valve guides	
9. Defective oil cooler (if so equipped)	9. Crack in cooler tubes
10. Defective piston rings	10. Glazed, scuffed, worn, stuck, improperly installed; ring grooves worn; improper break-in; wrong end gap
11. Defective cylinders	11. Out of round, scored, tapered glazed; excessive piston to cylinder clearance; cracked piston
12. Excessive bearing clearance	

WATER IN ENGINE

IMPORTANT INFORMATION

IMPORTANT: First determine location of water in engine. This information can be of great help when trying to determine where the water came from and how it got into the engine. The three most common problems are "water on top of pistons, water in crankcase oil, water in crankcase oil and on top of pistons".

The first step, after locating water, is to remove all the water from the engine by removing all spark plugs and pump cylinders out by cranking engine over. Next change oil and filter. Now, start engine and see if problem can be duplicated. If problem can be duplicated, there more than likely is a mechanical problem. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If water is contained to cylinder(s) only, it is usually entering through the intake system, exhaust system, or head gasket.

If the water is contained to crankcase only, it is usually caused by a cracked or porous block, a flooded bilge, or condensation.

If the water is located in both the cylinder(s) and the crankcase, it is usually caused by water in the cylinders getting past the rings and valves, or complete submersion.

Checking for rust in the intake manifold or exhaust manifolds is a good idea. Rust in these areas will give clues if the water entered through these areas.

WATER ON TOP OF PISTONS

CAUSE	SPECIAL INFORMATION
1. Operator shut engine off at high RPM	
2. Engine "diesels" or trys to run backwards	2. Engine out of tune, poor fuel, high idle RPM, timing set too high
3. Rain water running into flame arrestor	3. Hatch cover
4. Spark plug misfiring	4. Improper combustion causes moisture in the air to accumulate in the cylinder
5. Backwash through the exhaust system	
6. Improper engine or exhaust hose installation	6. Refer to Section 6, Part C for exhaust specifications
7. Cracked exhaust manifold	
8. Improper manifold to elbow gasket installation	
9. Loose cylinder head bolts	
10. Blown cylinder head gasket	10. Check for warped cylinder head or cylinder block
11. Cracked valve seat	
12. Porous or cracked casting	12. Check cylinder heads, cylinder block, and intake manifold

WATER IN CRANKCASE OIL

CAUSE	SYMPTOM
1. Water in boat bilge	1. Boat has been submerged or bilge water was high enough to run in through dipstick tube.
2. Water seeping past piston rings or valves	2. Refer to "Water in Engine" ("On Top of Pistons")
3. Engine running cold	3. Defective thermostat, missing thermostat; prolonged idling in cold water
4. Intake manifold leaking near a water passage	
5. Cracked or porous casting	5. Check cylinder head, cylinder block, and intake manifold

ENGINE OVERHEATS (MECHANICAL)

CAUSE	SPECIAL INFORMATION
1. Engine RPM below specifications WOT (engine laboring)	1. Damage or wrong propeller; growth on boat bottom; false bottom full of water
2. Wrong ignition timing	2. Timing too far advanced
3. Sticking distributor advance weights	
4. Spark plug wires crossed (wrong firing order)	
5. Lean fuel mixture	5. Refer to "Carburetor Malfunctions" in this section
6. Wrong heat range spark plugs	
7. Exhaust restriction	
8. Valve timing off	8. Jumped timing chain and/or gears, or improperly installed
9. Blown head gasket(s)	9. A blown head gasket(s) normally cannot be detected by a compression check. Normally the engine will run at normal temperature at low RPM, but will overheat at speeds above 3000 RPM. **Engines that are seawater cooled:** Using a clear plastic hose look for air bubbles between seawater pump and engine. If there are no bubbles present, install clear plastic hose between thermostat housing and manifold(s). If air bubbles are present at a higher RPM it is a good indication there is a blown head gasket. Refer to Section 6, Part A.
10. Insufficient lubrication to moving parts of engine	10. Defective oil pump, plugged oil passage, low oil level

ENGINE OVERHEATS (COOLING SYSTEM)

CAUSE	SPECIAL INFORMATION
IMPORTANT: The first step is to verify if the engine is actually overheating or the temperature gauge or sender is faulty.	**IMPORTANT: Best way to test gauge or sender is to replace them.**
1. Loose or broken drive belt	
2. Seawater shut-off valve partially or fully closed (if equipped)	
3. Clogged or improperly installed sea strainer	
4. Loose hose connections between seawater pick-up and seawater pump inlet. (Models with belt driven seawater pump only)	4. Pump will suck air. Pump may fail to prime or will force air bubbles into cooling system.
5. Seawater inlet hose kinked or collapsed	
6. Seawater pick-up clogged	
7. Obstruction on boat bottom causing water turbulence	7. Obstruction will be in front of seawater pick-up, causing air bubbles to be forced into cooling system.
8. Defective thermostat	
9. Exhaust elbow water outlet holes plugged	
10. Insufficient seawater pump operation	10. Worn pump impeller
11. Obstruction in cooling system such as casting flash, sand, rust, salt, etc.	11. Refer to water flow diagram for engine type being serviced
12. Engine circulating pump defective	
13. Also refer to "Engine Overheats (Mechanical)"	13. See "Index".
IMPORTANT: In addition to previous checks, make the following checks if engine is equipped with closed cooling.	
14. Low coolant level	
15. Anti-freeze not mixed properly	15. Anti-freeze should be mixed 50/50 or maximum 60/40. 60% anti-freeze, 40% water.
16. Heat exchanger cores plugged	
17. Water hoses reversed at the water distribution block	17. Refer to water flow diagrams Section 6, Part C
18. For further testing of the closed cooling system	18. Refer to Section 6, Part B

INSUFFICIENT WATER FLOW FROM MC-I/Alpha One STERN DRIVE UNIT SEAWATER PICKUP PUMP

CAUSE	SPECIAL INFORMATION
1. Seawater shut-off valve partially or fully closed (if equipped)	
2. Water pickups clogged with foreign material	
3. Kinked or broken bell housing-to-gimbal housing water tube hose	
4. Corroded thru gimbal housing water tube	
5. Water pickup inserts warped. (Engine will overheat while boat is underway only.)	5. Pickup inserts must not protrude above gear housing surface or inserts will create an irregular or turbulent water flow over the water pickup holes. Consequently, this may cause loss of cooling water and subsequent engine overheating. This condition also can be identified by cavitation burn (pitting, erosion) on the gear housing in the area aft of the water pickup inserts.
6. Damaged gear housing or accessories improperly installed on boat bottom or transom (speedometer pickup, depth sounder transducer, etc.). Substantial amount of barnacles or other marine growth on gear housing or boat bottom. (Engine will overheat while underway only.)	6. An object or an irregularity on boat or gear housing in area close to water pickups could create turbulence in water flow going to water pickups. This could aerate the water flow and cause engine to overheat.
7. Stern drive installed too high on transom or drive unit trimmed too far out allowing air to be drawn into pump. (Engine will overheat while underway only.)	7. Contact boat company if stern drive is installed too high. Instruct operator on proper trimming technique if unit is trimmed out too far.
8. Bell housing-to-drive shaft housing "O" ring missing or damaged	
9. Faulty seawater pickup pump	
10. Seawater pickup pump water tube corroded thru	
11. Drive shaft housing water pocket cover cracked	
12. Broken-off impeller blade or other obstruction in water passages (usually lodges in drive shaft housing water pocket cover or cross-drilled water passage).	12. To check cross-drilled water passage in drive shaft housing, remove welch plug and pipe plug located under decal on starboard side of housing. Drive unit must be shifted into reverse to remove pipe plug.
13. Water passage in drive shaft housing improperly drilled	

INSUFFICIENT WATER FLOW FROM BELT DRIVEN SEAWATER PICKUP PUMP

CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Loose or broken
2. Seawater shut-off valve partially or fully closed	
3. Clogged or improperly installed sea strainer	
4. Loose hose connections between seawater pickup and seawater pump inlet	4. Pump will suck air, pump may fail to prime or will force air bubbles into cooling system.
5. Seawater inlet hose kinked or plugged	
6. Seawater pickup clogged	
7. Obstruction on boat bottom causing water turbulence	7. Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
8. Faulty seawater pump	

POWER STEERING

POOR, ERRATIC, OR NO ASSIST

CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Broken or out of adjustment
2. Low fluid level	
3. Air in system	3. Air leak in lines, pump, or air from installation. Refer to Section 7 for bleeding procedure.
4. Leaking hoses	4. Refer to Section 7 for bleeding procedure.
5. Steering cable and/or steering helm	5. Cable or helm partially froze from corrosion or rust; cable over lubricated; improper cable installation
6. Binding in stern drive unit	6. Refer to appropriate "Stern Drive Service Manual"
7. Restriction in hydraulic hoses	7. Causes a loss of pressure
8. Control valve not positioned properly, not balanced properly, or the mounting nut is loose	
9. Mounting bracket adjusting screw loose or mounting tube is loose	
10. Faulty pump	10. Flow control valve may be sticking
11. Worn piston ring or scored housing bore in cylinder	11. Causes loss of pressure
12. Leaking valve body or loose fitting spool	

NOISY PUMP

CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Check tension
2. Low fluid level	
3. Air in fluid	3. Air leak in lines, pump, or air from installation. Refer to Section 7 for bleeding procedure.
4. Faulty pump	4. Use stethoscope to listen for noise in the pump
5. Restricted fluid passages	5. Kinks or debris in hoses or debris in passages
6. Stop nut adjusted improperly	6. Refer to appropriate "Stern Drive Service Manual".
7. Steering cables installed that do not meet BIA standards	7. Refer to appropriate "Stern Drive Service Manual".

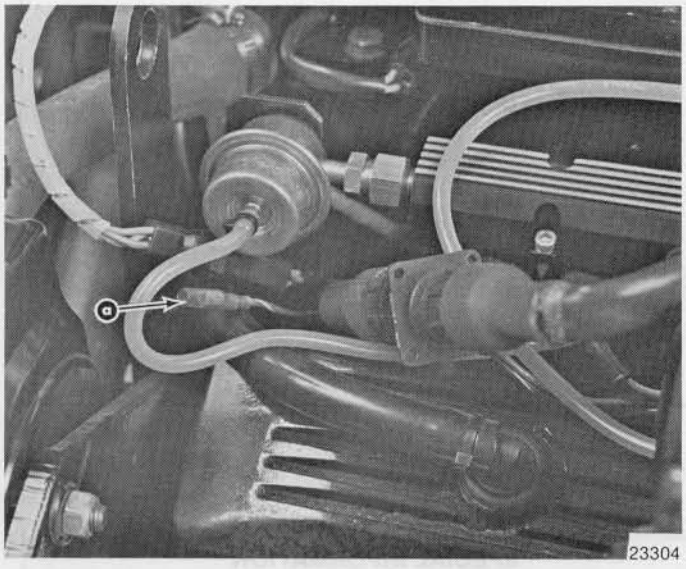
FLUID LEAKS

CAUSE	SPECIAL INFORMATION
1. Loose hose connections	1. Refer to Section 7 for bleeding procedure.
2. Damaged hose	
3. Oil leaking from top of pump	3. System overfilled; fluid contains water; fluid contain air
4. Cylinder piston rod seal	
5. Faulty seals in valve	
6. Faulty seals or "O" rings in pump	
7. Cracked or porous metal parts	

320 EFI Troubleshooting

TIMING PROCEDURE

It is essential to ground the red/yellow wire (Figure 1) located in the wire harness, for adjusting the timing. Failure to do so will obtain a retarded adjustment. The initial timing mark on the harmonic balancer is marked with a number 0 and should be adjusted to 12 degrees BTDC. This mark may not be highlighted. The full advance setting (Marked 34 degrees) can be checked after initial timing is adjusted.

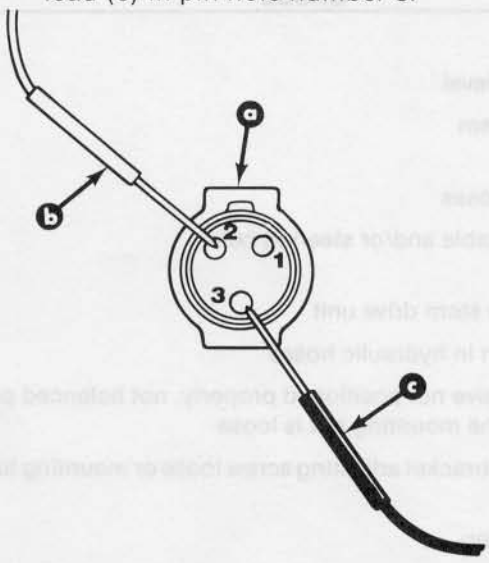


a - Red/Yellow Wire

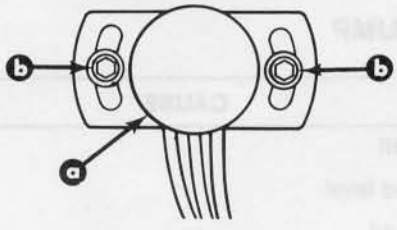
Figure 1.

SETTING THE THROTTLE SENSOR

1. Connect the digital multi-meter (incorporated in tester P/N 91-16850) to connector (a) by putting red meter lead (b) in pin hole number 2 and black meter lead (c) in pin hole number 3.



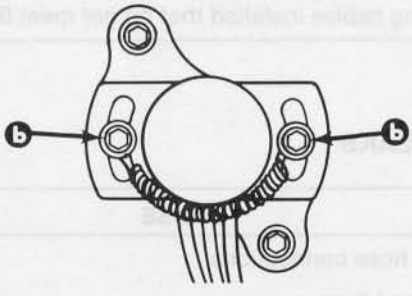
2. Put meter dial in 2K position. Rotate sensor (a) counterclockwise until a reading of 50 to 100 ohms is reached. Then tighten screws (b).



SAFETY WIRE INSTALLATION

IMPORTANT: Screws (b) securing throttle position sensor must be safety wired.

Safety wire the screws as shown below.



IMPORTANCE OF RETURN LINES

The fuel system for the 320 EFI incorporates an electric fuel pump with a water separating filter. The pump is pressure regulated to maintain a constant pressure of 39 PSI (268.90 kPa) between the fuel rails and intake manifold.

The system also incorporates a fuel return line. The return line must be installed and must not be any smaller than 1/4 in. (6.4mm) I.D. Failure to install or use the fuel return line could cause excessive pressure on the rails or injectors. The fuel pump and water separating filter must be mounted with in 12 in. (305mm) of the engine to comply with USCG regulations/specifications.

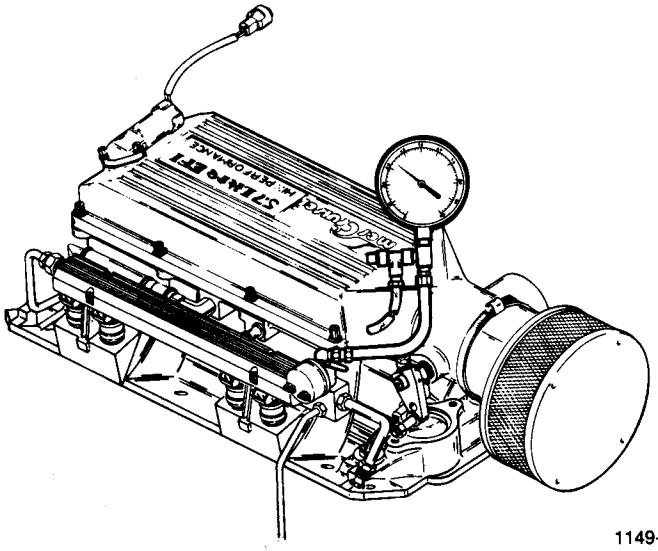
ELECTRIC FUEL PUMP PRESSURE TESTER (P/N 91-16850)

An Instruction Book accompanies the Tester.

MerCruiser - Electric Fuel Pump Pressure Test

This test can tell if the electric fuel pump is capable of producing the correct fuel pressure of 30-40 PSI. (205 to 274 kPa) needed for normal engine operation.

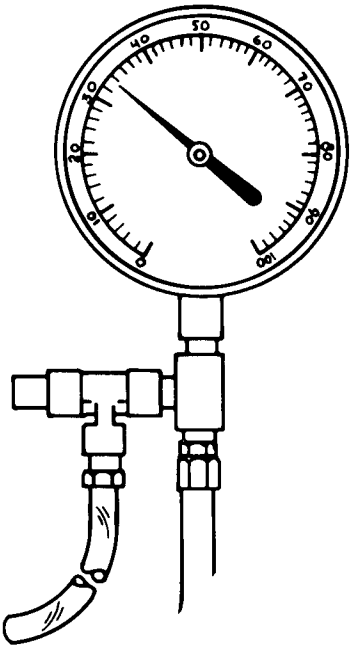
1. Connect pressure gauge to pressure port.



1149-H

2. Put ignition key switch in "ON" position with oil pressure sensor bypassed.

3. Take fuel pressure reading.



4. Reading must be 30 to 40 PSI. (205 to 274 kPa). Refer to the Troubleshooting Chart following for further testing.

Troubleshooting Fuel System

COMPONENT CHECK	RESULT	REMEDY
1. **Testing Fuel Pump Circuit** (Turn Key to **run** position and oil pressure sensor bypassed.)	pump runs	Check fuel pressure STEP 4
	pump doesn't run	Check for 12 volts at the pump with key in **run** position and oil pressure sensor bypassed
		(No Voltage) Check harness, ECU box. (See test procedure following.)
		(Voltage) Check pump STEP 2.
2. **Pump Test** (Install jumper wire from 12V source to "+" terminal on pump)	pump runs	Check front mounted rectifier STEP 5
	pump doesn't run	Check oil pressure sensor STEP 3
3. **Oil Pressure Sensor** (Remove both leads from sensor and connect leads together)	pump runs	Replace oil pressure sensor
	pump doesn't run	Replace pump
	pump doesn't run	Check wire harness, ECU box. (See test procedure following)
4. **Testing Fuel Pressure** (Install pressure tester P/N 91-16850 per instructions.)	high or low pressure	Replace fuel pressure regulator
5. **Checking Rectifier** (Unplug harness, check with ohm meter. One meter lead on termianl #3, other meter lead on terminal #1 or #2. Noting the value of the meter reading, reversing the connection should obtain the opposite value.)	shorted or open reading	Replace rectifier, refer to STEP 1 to retest pump
	checked ok	Check harness, ECU box. (See test procedure following)

ENGINE TURN OVER WON'T START

COMPONENT CHECK	RESULT	REMEDY
1. **Spark Check**	No Spark	Check ignition, Section 4B of Service Manual 90-14499
	Spark	Check fuel system. Refer to troubleshooting chart preceding
2. **Fuel Pressure** (Install gauge in pressure tap, turn ignition key to start position, minimum 32 lbs. fuel pressure)	Fuel Pressure	Check ECU box
	No Fuel Pressure	Check fuel supply, shut off valve, fuel filter, tank pick-up, tank vent
3. **Fuel Filter** (Change filter if plugged)	No Fuel Pressure	Check front mounted rectifier
4. **Checking Rectifier** (Unplug harness, check with ohm meter. One meter lead on terminal #3, other meter lead on terminal #1 or #2. Noting the value of the meter reading, reversing the connection should obtain the opposite value)	No Fuel Pressure	Check fuel pump
5. **Fuel Pump** (Install jumper wire from 12V source to "+" terminal on pump)	No Fuel Pressure	Replace pump
	Fuel Pressure	Check oil pressure sensor
6. **Oil Pressure Sensor** (Remove both leads from sensor and connect leads together)	Fuel Pressure	Check elsewhere in wiring of engine or boat
	No Fuel Pressure	Oil sensor bad or no oil pressure. CAUTION: Check oil in crankcase, start engine to check oil pressure. If oil pressure is ok, replace oil sensor

ENGINE ACCELERATION IS SLUGGISH
NO FAST IDLE WHEN COLD

COMPONENT CHECK	RESULT	REMEDY
1. **Throttle Position Sensor** (Ohms check Rx1; throttle closed 50-100 ohms. Throttle wide open over 180 ohms)	Low or High Ohm Reading	Replace throttle position sensor
2. **Air Valve** (Hold finger on valve opening to check for air flow into valve)	Air Valve Ok	Check ECU box
	Air Valve Not Working	Check water temperature sensor
3. **Water Temperature Sensor** (Remove leads and connect together)	Air Valve Ok	Replace sensor
	Air Valve Not Working	Replace air valve

ENGINE MISFIRES, RUNS ROUGH

COMPONENT CHECK	RESULT	REMEDY
1. **Spark Check**	No Spark	Refer to Section 4B of Service Manual 90-14499
	Spark	Check battery
2. **Battery Check** (Use volt meter, check for 12 volts)	Not 12V	Change battery
	12V	Check fuel system
3. **Fuel Pressure** (Install pressure gauge per instructions, pressure MUST range from 30 lbs. at idle to 40 lbs. at wide open throttle)	No or Low Pressure	Check fuel filter. Check fuel pump STEP 6.
	High Fuel Pressure	Change fuel regulator
	Low Fuel Pressure	Check fuel injectors. Change fuel regulator
4. **Injectors** (With engine warm and idling, remove electrical leads one at a time from injectors) NOTE: If there are four injectors misfiring at once such as 1, 4, 6, 7 or 2, 3, 5, 8 test ECU box	RPM Drop	Injectors Ok
	No RPM Drop	Replace injectors or spark plugs as needed
	Injectors Ok	Check ECU Check fuel filter
5. **Fuel Filter** (Replace if clogged)	No or Low Fuel Pressure	Check fuel pump
6. **Fuel Pump** (Must have 12V to pump and good ground connections)	No Fuel Pressure	Replace pump
	Low Fuel Pressure	Replace fuel regulator, if pressure is still low replace pump

TROUBLESHOOTING - THE EFI ELECTRICAL SYSTEM

IMPORTANT: When checking the electronic components of the EFI system, only the EFI Tester (P/N 91-11001A2) can be used. This tester tests the EFI components as a system.

By following the test procedure, a defective component can be found. Retest the complete system after the defective component is replaced.

Following is the set-up and testing procedure for the EFI Tester.

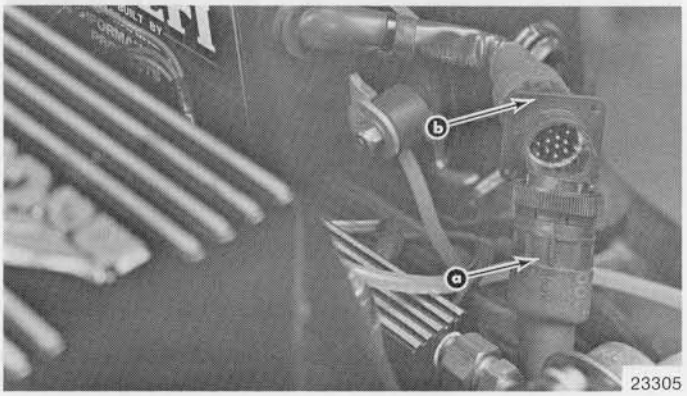
TESTING EFI ELECTRICAL SYSTEM

EFI TESTER SET-UP PROCEDURE - FOR CHECKING EFI SYSTEM ON ENGINE

⚠CAUTION
Do not start or run engine with EFI system tester connected.

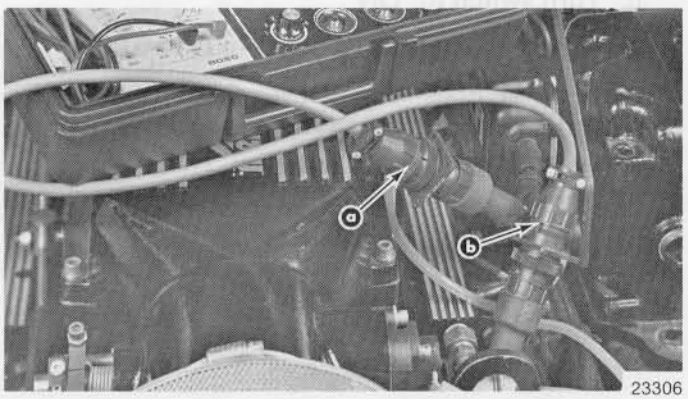
IMPORTANT: Check engine battery voltage before using tester. If below 10 volts, recharge or replace battery.

1. Disconnect EFI harness (a) from ECU (b).



23305

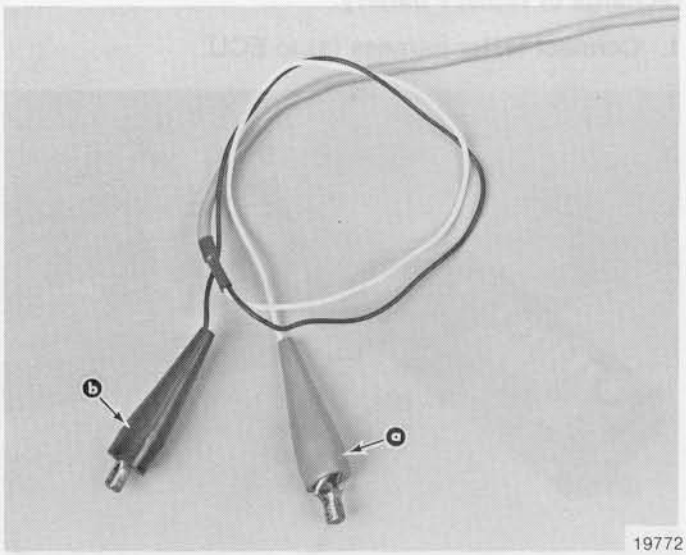
2. Connect tester harness (a) to ECU and tester harness (b) to EFI harness.



23306

3. Connect (red color) tester battery clip lead (a) to +12V terminal.

   Connect (black color) tester battery clip lead (b) to engine ground.



19772

4. Connect red (a) and black (b) color test leads into meter.

19771

5. a. Turn meter selector (a) to 20VDC position.
   b. Turn power switch to "ON".
   c. Meter reading should be more than 0.00V.
   d. If meter doesn't read over 0.00V, then check tester battery clip leads for good connections or correct polarity.
6. The EFI tester is now set-up for checking the EFI system.

EFI - TESTER SET-UP PROCEDURE - FOR TESTING ECU IF REMOVE FROM ENGINE

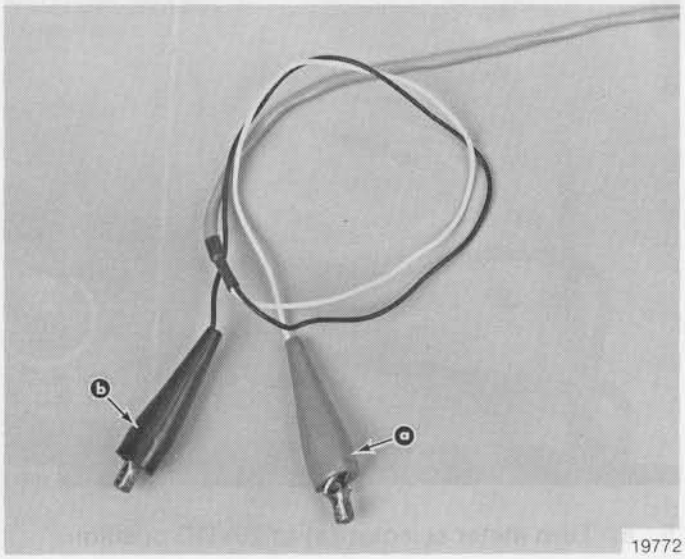
IMPORTANT: Check battery voltage of the 12 volt battery used in Step 2 before using tester. If below 10 volts, recharge or replace battery.

1. Connect tester harness (a) to ECU.

23307

2. Connect (red color) tester battery clip (a) to positive (+) terminal on a 12 volt battery.

   Connect (black color) tester battery clip (b) to negative (-) terminal on the battery.



19772

3. Connect red (a) and black (b) color test leads into meter.

19771

4. a. turn meter selector to 20VDC position.
   b. Turn switch to "ON".
   c. Meter reading should be more than 0.00V.
   d. If meter doesn't read over 0.00V, then check tester battery clip leads for good connections for correct polarity.
5. The EFI tester is now set-up for checking the EFI system.

EFI Harness and EFI Wire Continuity Test

Fuel Injector Test

For 320 EFI 4 Cycle Models

Refer to Page 2 to set-up tester

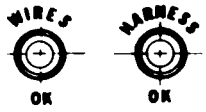
EFI HARNESS TEST

Testing EFI Harness if Engine is on Boat

1. "Wires OK" test lamp should light which indicates harness is good.
2. "Harness OK" test lamp not used in 320 EFI continuity test.

Testing EFI Harness if Engine is Removed from Boat

1. Connect engine battery leads to a 12 volt battery.



Corrective Action if Test Lamp does not Light

Refer to EFI wire continuity check below to independently check each wire in the harness to locate the defective wire(s).

EFI WIRE CONTINUITY TEST

Testing EFI Wires if Engine is on Boat

1. Turn ignition key to "ON" position
2. Turn continuity check switch to each of the following wire check position.

Testing EFI Wires if Engine is Removed from Boat

1. Connect engine battery leads to a 12 volt battery.
2. Turn continuity check switch to each of the following wire check position.

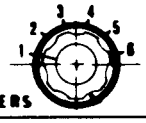
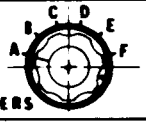
Locating Faulty Wire(s)

If test lamp lights, wire indicated in chart below is good

If test lamp does not light, the problem is in the indicated wire

H1	circuit between No. 1, 4, 6, 7 injectors and ECU
H3	circuit between No. 2, 3, 5, 8 injectors and ECU
H4	12V wire to ECU
H5	12V wire to ECU
H10	Ground to ECU Box wire(s)

FUEL INJECTOR TEST

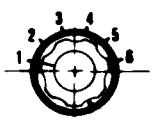
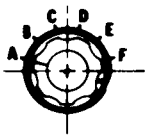
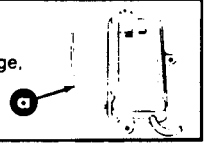
	Switch Position ECU PARAMETERS 	Switch Position SYSTEM PARAMETERS 	Testing Injectors
Test Steps	Set ECU PARAMETERS Switch to each of the following positions.	Set SYSTEM PARAMETERS switch to each of the following position.	Place your finger on the terminal part of the injectors being tested. If injector is good, you will feel the injector pulsating.
1	6	D	Operates No. 1, 4, 6, 7 injectors.
2	6	F	Operates No. 2, 3, 5, 8 injectors.

ECU Test
Throttle Sensor
Air Temperature Sensor Test
Cold Start Enrichment Test
Ignition Kit Test
Pressure Transducer Test

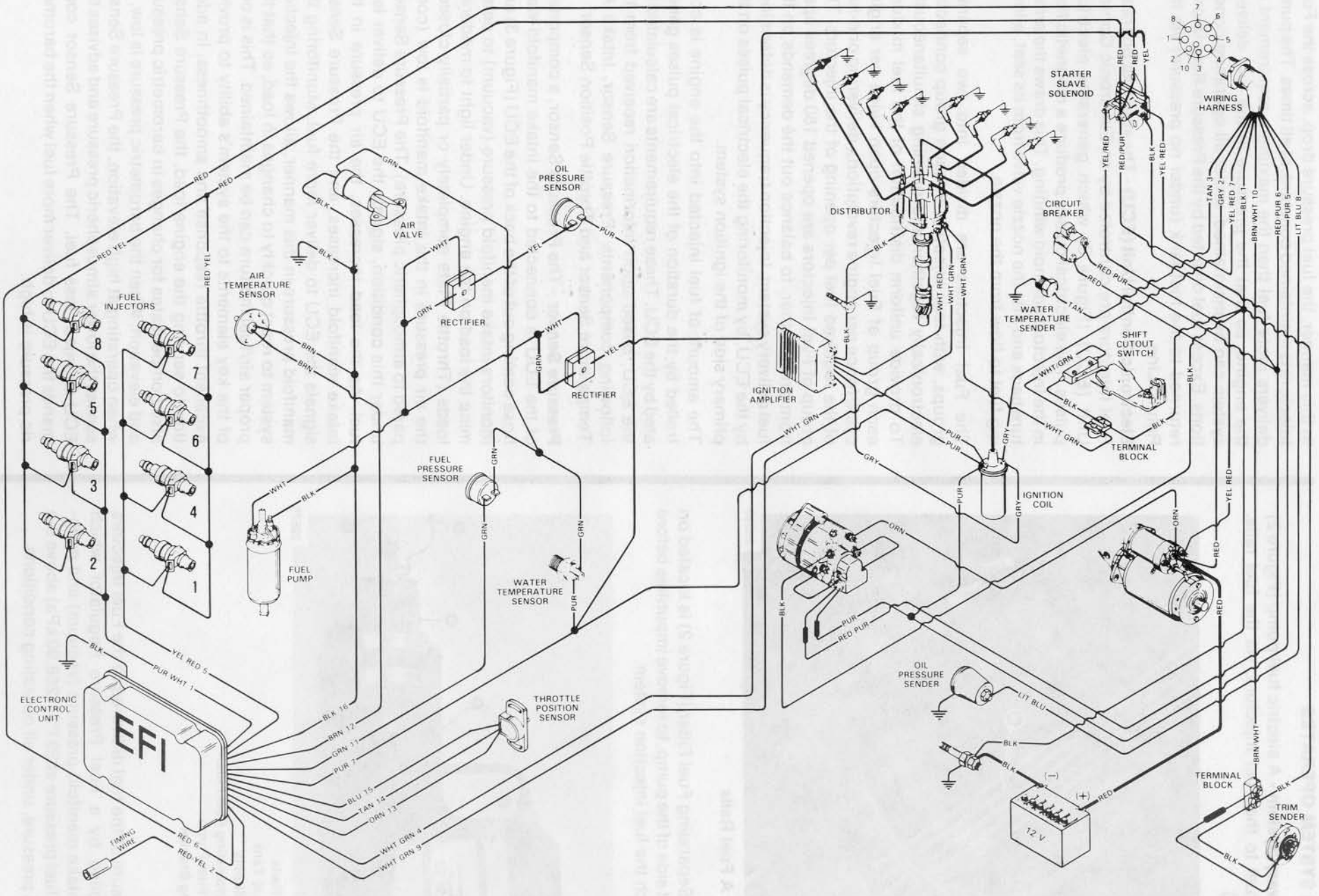
320 EFI 4 Cycle ECU Part No. 11350A3

Refer to Page 2 to set-up tester

IMPORTANT: The original EFI tester is in an aluminum carrying case and must not be used to test a 320 EFI. May result in damage to ECU.

		Switch Position  ECU PARAMETERS	Switch Position  SYSTEM PARAMETERS	**Normalizing** the EFI System ECU NORMALIZE	1. Set ECU Parameters switch to position 2. 2. Set System Parameters switch to Position A. 3. Rotate ECU Normalize knob to obtain reading of 1.10 on tester meter. Do not move ECU Normalize knob once 1.10 reading is obtained. The system is now normalized. 4. If you can not obtain 1.10 meter reading the ECU is faulty.
	Test Steps	Set ECU PARAMETERS Switch to each of the following positions.	Set SYSTEM PARAMETERS switch to each of the following positions.	Specified Reading	CORRECTIVE ACTION if you cannot match specified reading.
EFI COMPONENTS TEST	ECU TEST	**NORMALIZE** THE EFI SYSTEM. REFER TO INSTRUCTIONS IN UPPER RIGHT HAND CORNER OF THIS CHART.			
		1	3	A	.73 ± .02	Faulty ECU
		2	4	A	.73 ± .02	Faulty ECU
		3	5	A	.47 ± .02	Faulty ECU
		4	6	A	.28 ± .02	Faulty ECU
	THROTTLE SENSOR TEST	**NORMALIZE** THE EFI SYSTEM. REFER TO INSTRUCTIONS IN UPPER RIGHT HAND CORNER OF THIS CHART.			
		1	4	B	**Closed Throttle Low .74** Wide Open Throttle High 1.40	Throttle sensor faulty or out of adjustment or harness faulty if meter reading does not change with sudden throttle motion. Note (1)
	AIR TEMPERATURE SENSOR TEST	**NORMALIZE** THE EFI SYSTEM. REFER TO INSTRUCTIONS IN UPPER RIGHT HAND CORNER OF THIS CHART.			
		1	2	C	Low 1.02 High 1.17	If meter reading is above 1.17, there is a faulty air temperature sensor or open sensor lead. If meter reading is below 1.02, there is a faulty air temperature sensor or shorted sensor lead.
	COLD START ENRICHMENT TEST	**NORMALIZE** THE EFI SYSTEM. REFER TO INSTRUCTIONS IN UPPER RIGHT HAND CORNER OF THIS CHART.			
		1	6	A	Press cold start enrichment button. Meter reading should be .28 - 1.50. If meter reeading is not .28 - 1.50 the ECU or harness is faulty. COLD START ENRICHMENT	
	IGNITION KILL TEST	**NORMALIZE** THE EFI SYSTEM. REFER TO INSTRUCTIONS IN UPPER RIGHT HAND CORNER OF THIS CHART.			
		1	2	A	Press Ignition Kill button. Meter reading should decrease 2 to 3 times, then fall to 0.01 Example: 1.10 0.40 0.01 IGNITION KILL	
	PRESSURE TRANSDUCER TEST	**NORMALIZE** THE EFI SYSTEM. REFER TO INSTRUCTIONS IN UPPER RIGHT HAND CORNER OF THIS CHART.			
		1	2	A	Disconnect ECU transducer tube (a) from fitting on engine. Draw air from tube. Meter reading should decrease as air is drawn from tube. If no number change, the ECU is Faulty 	

NOTE (1) The wide open throttle reading will only appear momentarily with a quick throttle movement.



Engine Electrical System Wiring Diagram

913-HR

HOW EFI SYSTEM OPERATES

Fuel Delivery System - A electric fuel pump (Figure 2) delivers fuel to the Fuel Injectors, via the fuel rails. (Figure 1)

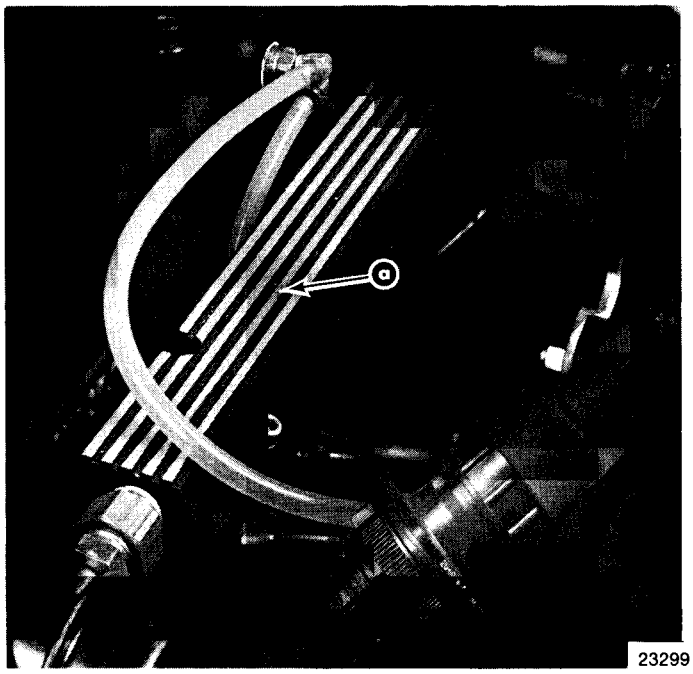
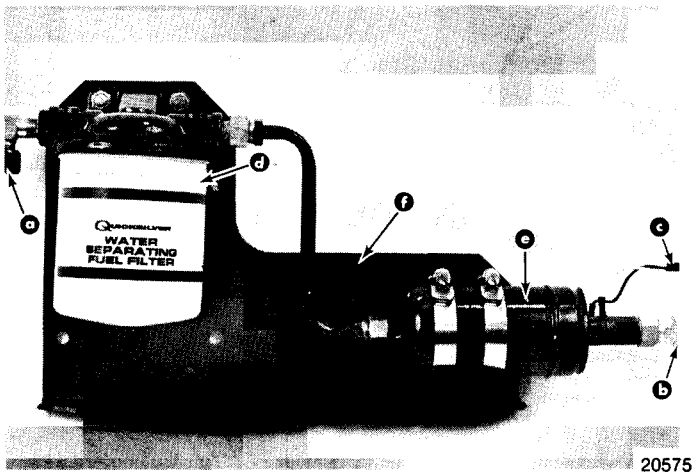


Figure 1. A Fuel Rails

A Water Separating Fuel Filter (Figure 2) is located on the outlet side of the pump, to remove impurities before they reach the fuel injection system.



a - To Fuel Rails
b - From Fuel Tank
c - 12 Volt Supply
d - Water Separating Fuel Filter
e - Electric Fuel Pump
f - Mounting Bracket

Figure 2.

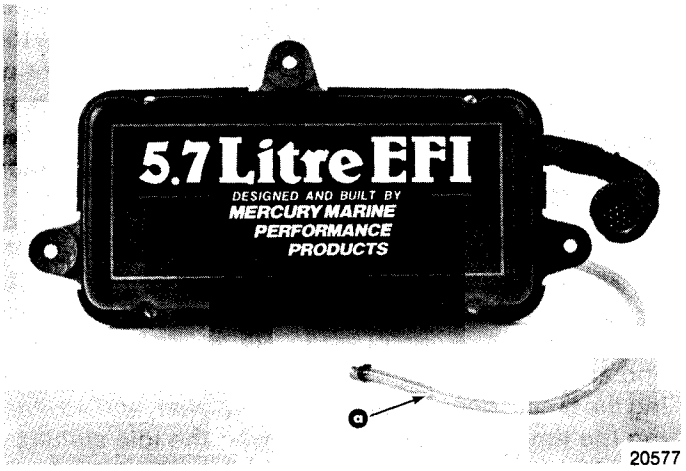
The pressure of the fuel delivered to the Fuel Injectors is controlled by a Fuel Pressure Regulator which senses intake manifold pressure (vacuum) and maintains the fuel pressure at 39 PSI (268.90 kPa) above the manifold pressure, under all operating conditions. In this manner, the fuel pressure drop, across the Fuel Injectors is maintained constant, at all times. The pump delivers more fuel than the maximum requirement of the engine, so that the pressure in the fuel delivery system can be maintained, under all operating conditions. Excess fuel diverted by the Pressure Regulator is returned to the fuel tank (under no pressure) via the Return Line.

Electronic Control Unit (ECU) - The solenoid operated Fuel Injectors are controled by an Electronic Control Unit (ECU) (Figure 3) which generates electrical pulses. The electrical pulses produce a magnetic field in the Injectors solenoid winding. This draws the armature back and lifts the nozzle valve from its seat, allowing fuel to flow from the nozzle.

The Fuel Injectors are divided into two separate groups, with four injectors in each group connected electronically together and opening simultaneously. To provide uniform distribution of the fuel mixture, each group of Fuel Injectors open twice per engine cycle (once per engine revolution), delivering one-half of the required fuel per opening of the injectors. The group of Fuel Injectors are opened 180 degrees apart from one another, to balance out the demands on the fuel delivery system. Injection frequency is determined by the ECU, by monitoring the electrical pulses on the primary side of the ignition system.

The amount of fuel injected into the engine is controlled by the duration of the electrical pulses generated by the ECU. These requirements are calculated by the ECU, based upon information received from the following components: Pressure Sensor, Intake Air Temperature Sensor and Throttle Position Sensor.

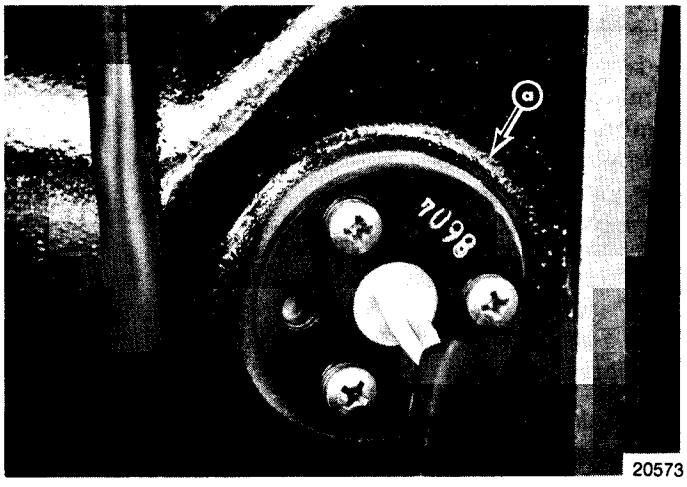
Pressure Sensor - The Pressure Sensor, a component of the ECU is connected to the intake manifold via a hose coming out of the back of the ECU (Figure 3) and monitors intake manifold pressure (vacuum) to determine the load on the engine. Under light to moderate loads (Throttle Plate completely or partially closed), the air pressure in the intake manifold is low (compared to atmospheric pressure). The Pressure Sensor, under this condition, signals the ECU to deliver less fuel. As the load increases, the air pressure in the intake manifold increases, and the Pressure Sensor signals the ECU to deliver more fuel. Monitoring the manifold pressure in this manner, allows the injection system to react quickly to changes in load, so that the proper air/fuel mixture can be maintained. This is one of the key elements to the system's ability to provide excellent throttle response and smoothness. In addition to sensing the engine load, the Pressure Sensor also compensates for changes in barometric pressure and elevation. When the barometric pressure is low, or when operating at high elevation, the Pressure Sensor senses the lower atmospheric pressure and advises the ECU to inject less fuel. The Pressure Sensor commands the ECU to deliver more fuel when the barometric pressure is high.



a - Pressure Sensor

Figure 3.

Intake Air Temperature Sensor - The quantity of fuel injected into the engine, once the engine is warm, is controlled primarily by the ECU Pressure Sensor. Air temperature affects air density which affects requirements. This is performed by the Intake Air Temperature sensor (Figure 4), located in the Air Intake System.

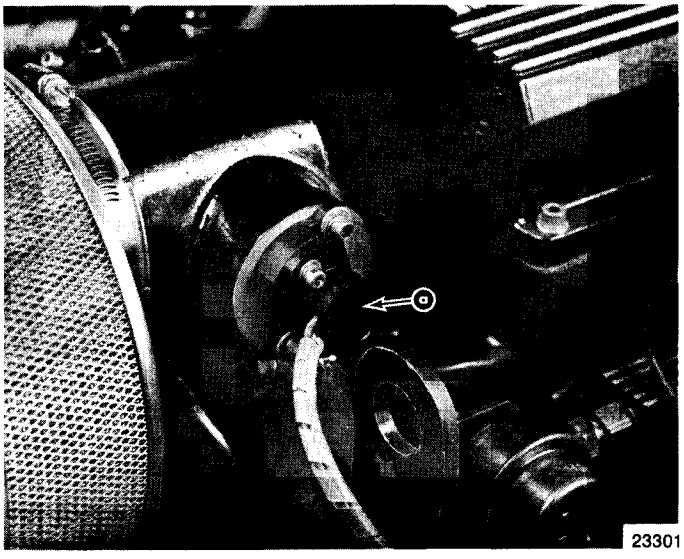


a - Intake Air Temperature Sensor

Figure 4.

As the air temperature decreases (air density increases), the sensor operating through the ECU, causes the amount of fuel injected to be increased, to maintain the proper air fuel mixture. The sensor causes the opposite to happen, when the intake air temperature increases.

Throttle Position Sensor - When the Throttle Plate opens quickly (mild to hard acceleration), a slight delay occurs before the Pressure Sensor reports this condition to the ECU. This slight delay results from the fact that the rise in pressure in the Pressure Sensor takes slightly longer than the change in the position of the Throttle Plate. In order to bridge this slight delay in response and prevent the engine from bogging, a Throttle Position Sensor (Figure 5) is incorporated into the system, which acts through the ECU to momentarily enrichen the air/fuel mixture. The throttle position sensor consists of a potentiometer (variable resistor), which is attached directly to the throttle shaft. When the throttle valve is opened, the ECU senses the speed at which the throttle is being opened, by calculating the change in resistance of the throttle position sensor. If mild to hard accleration is sensed, the ECU momentarily lengthens the electrical pulses to injection valves to inject more fuel. The amount of fuel added is a function of the throttle movement. **Above 3000 RPM, the acceleration circuit is disabled.**



a - Throttle Position Sensor

Figure 5.

Cold Start/Warm Up Devices

NOTE: These items are not separate components. They are incorporated, or components combined with, the ECU circuitry.

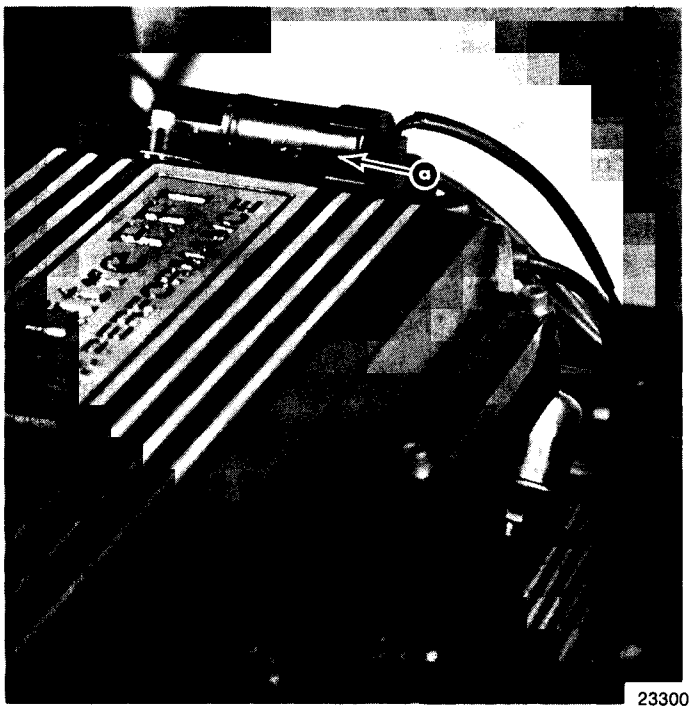
In a cold engine, fuel condenses on the intake manifold and cylinder heads. As a result, less fuel mixes with the intake air, than in a warm engine. Additional fuel must be added, under these circumstances, to obtain an ignitable air fuel mixture. To overcome the increased friction of a cold engine and maintain a steady idle speed, additional air also must be added, to increase the power output of the engine at idle. To handle the cold engine requirements, special circuitry is incorporated in the ECU, that works in conjunction with a cooling system Water Temperature Switch, Fuel Pressure Switch and an Auxiliary Air Valve.

When the engine is below 120° F (66° C) the cooling system Water Temperature Switch signals the ECU that additional fuel and air are required.

All cylinders are simultaneously primed with fuel once, during initial start up. This is accomplished by holding the injection valves open for up to one-half second. The duration of the prime is a function of engine temperature, which is monitored by a thermistor in the ECU. The prime is initiated, only after the fuel pressure in the fuel rails reaches 25 PSI, (172 kPa) as established by the Fuel Pressure Switch. The 25 PSI (172 kPa) is necessary to prevent an insufficient prime, should there be air in the fuel rails. The prime mode can be repeated, if needed, by turning the ignition switch off and then repeating the starting cycle.

After the initial prime, fuel enrichment is determined by the thermistor in the ECU, which controls the length of time that the Fuel Injectors are held open during each engine revolution.

The thermistor gradually reduces the amount of enrichment, as the engine warms up. Once the engine reaches 120° F (66° C) the cooling system Water Temperature Switch commands the ECU to cease fuel enrichment. When the engine is below 120° F (66° C), the Water Temperature Sensor actuates the Auxiliary Air Valve (Figure 6), to provide additional air to the engine. This air mixes with the enriched fuel supply, causing the engine to produce more power for easier starting and smooth warm up operation. This system works in conjunction with the Idle Stabilizer Circuit, incorporated in the ECU box, to produce a stable fast idle speed of approximately 1000 RPM during the warm up period. The engine automatically returns to normal idle speed (600 RPM), when the cooling system Water Temperature Switch senses the engine has reached 120° F (66° C).



a - Auxiliary Air Valve

Figure 6.

Idle Stabilizer - On engines with fuel injection, the fluctuations in intake manifold pressure can cause the engine to hunt at idle, as the pressure sensor is continually attempting to compensate for the pressure changes. To prevent this condition, and to allow low, stable idle speeds, an Idle Stabilizer was incorporated in the ECU box.

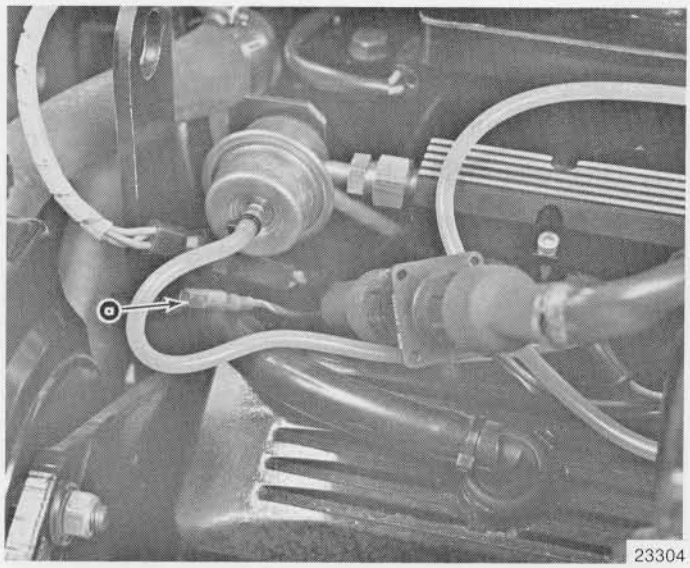
The Idle Stabilizer consists of a special circuit that works in conjunction with the Thunderbolt IV (H.E.I.) System. The circuit controls the electronic advance in the ignition amplifier, at the low RPM range, retarding and advancing the timing as necesasry. Since retarding the timing decreases the engine power, and advancing the timing increases the power, the idle stabilizer acts like a governor to stabilize the idle speed and minimize the possibility of stalling. An in gear idle speed of 600 RPM and out of gear idle speed of 620 RPM is obtained with this approach. Above 800 RPM, the timing is progressively advanced until it reaches the initial timing curve at approximately 2200 RPM. The initial timing curve is maintained above 2200 RPM by the Thunderbolt IV (H.E.I.) System with the Idle Stabilizer circuit no longer working.

When the engine is below 120° F (66° C) or whenever the engine is being cranked, the ignition timing is advanced equal to or slightly retarded from the initial timing curve, to allow easy starting and obtain a smooth idle. A thermistor in the ECU gradually retards the timing in accordance with the temperature of the air surrounding the engine, to maintain a fast idle speed of approximately 1000 RPM.

Once the engine reaches 120° (66° C), as established by the cooling system Water Temperature Switch, the Idle Stabilizer resumes its normal operation and the idle speed returns to 600-620 RPM.

The Idle Stabilizer also works in conjunction with the Throttle Position Sensor. Under a mild to hard acceleration from idle, the ignition timing is instantly advanced to the initial timing curve. This helps prevent a backfire and improves the throttle response.

Due to the Idle Stabilizer, a special procedure must be used to set the ignition timing. The timing must be set with the engine warmed up and idling, and with the RED-YELLOW WIRE (Figure 7), located on the front of the engine, grounded. This disables one bank of Fuel Injectors and advances the timing to the initial timing curve. The idle speed under this condition will be approximately 600 RPM.

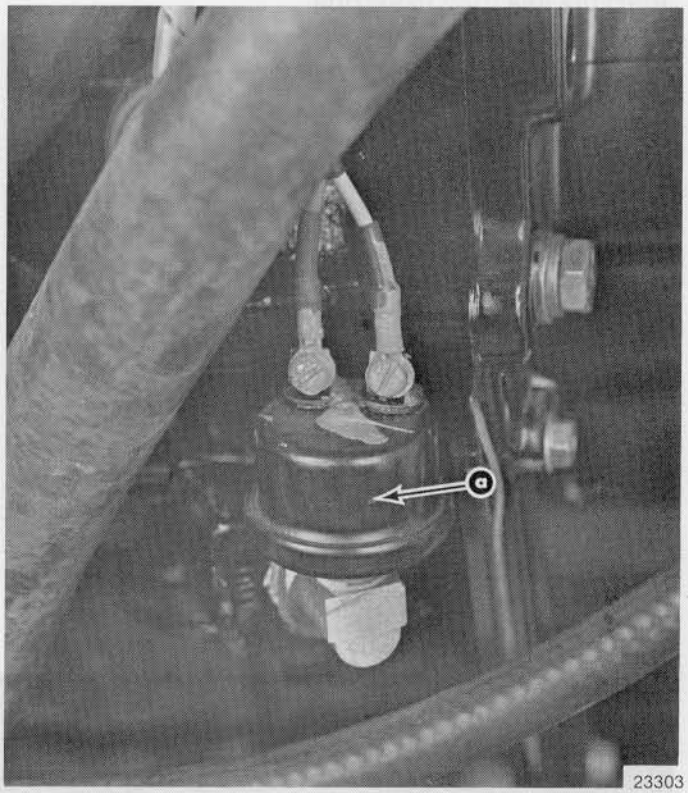


a - Red/Yellow Wire

Figure 7.

Overspeed Protection - In the event that the load on the engine should be lost (propeller leaving the water), the ECU incorporates special circuitry to limit the engine speed to 5600 RPM to help prevent internal engine damage. The special circuitry acts through the ignition system and causes the engine to miss, when it reaches the rev limit.

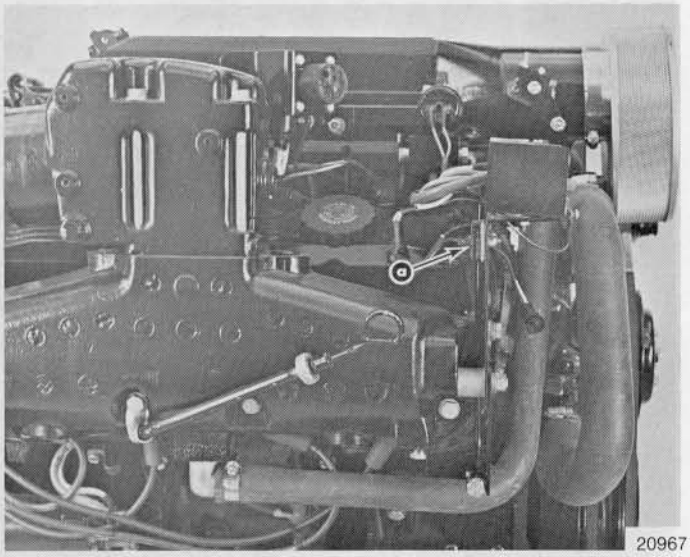
Fuel Pump Control/Loss of Oil - Pressure Protection - The fuel pump is controlled through the Ignition Switch and Oil Pressure Switch (Figure 8). The Ignition Switch activates the fuel pump only during cranking, to ensure instantaneous pump response. Once the engine starts and at least 4 PSI is generated in the lubrication system, the Oil Pressure Switch closes and energizes the pump. In the event of oil pressure failure or a stalled engine, the fuel pump wil be automatically turned off by the Oil Pressure Switch.



a - Oil Pressure Switch

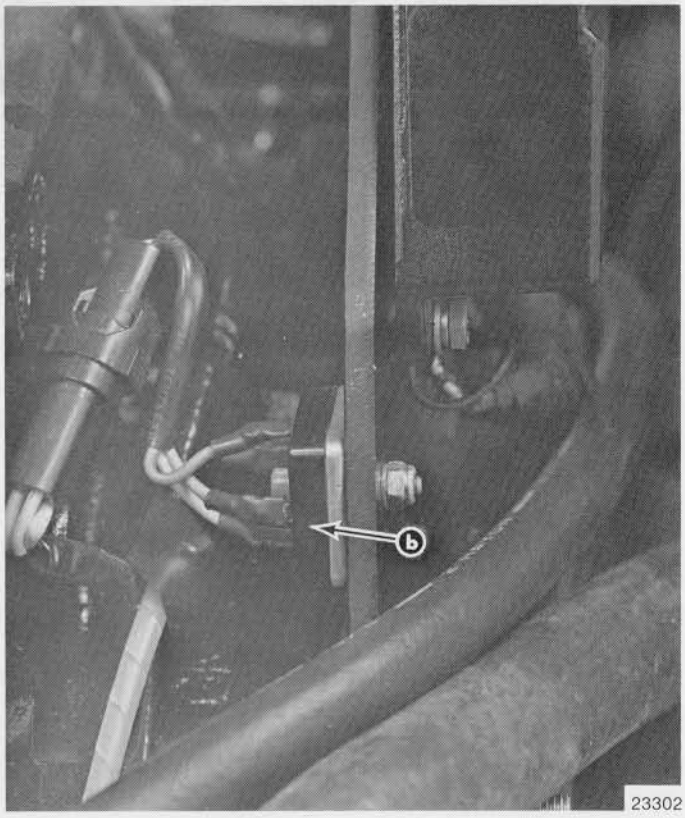
Figure 8.

Blocking Rectifiers - As mentioned earlier, the auxiliary Air Valve and Fuel Pump are energized during the cranking mode. This is accomplished by an interconnection into the starter motor excitation circuit using Blocking Rectifiers (Figure 9). If a direct connection was made into this circuit, the possibility exists that the engine could momentarily start if a remote start switch was used to run the starter. It would also be possible to actuate the starter if the fuel pump was hot wired during servicing. Incorporating the Blocking Rectifiers prevents this from occurring.



a - Front Rectifier

Figure 9.



b - Rear Rectifier

Figure 9.

Limp-Home Feature - The MerCruiser EFI system has been designed to allow the engine to run (with some degradation in performance), if one or more of the following should fail:

1. Throttle Position Sensor
2. Intake Air Temperature Sensor
3. Cooling System Water Temperature Switch
4. Pressure Sensor
5. Injector Valve Bank
6. Fuel Pressure Switch
7. Oil Pressure Switch
8. Some ECU Circuitry

Troubleshooting

In case of trouble, check first whether all items of the present installation and operation instructions have been complied with.

Trouble	Possible Cause	Remedy
1. Transmission gears cannot be shifted	Shifting lever is loose	Tighten clamping screw on shifting lever
	Remote control does not permit lever travel required for testing	Lift remote control off, if gears can be shifted by hand, correct remote control
	Remote control faulty	Repair remote control
	No shifting pressure available.	Refer to 7.
2. Gears are shifted sluggishly	Lever travel of remote control is too short; lever shift just short of minimum traveling distance	Lift remote control off, if gears can be shifted by hand, correct remote control
3. Clutch is slipping, i.e. propeller speed too low as compared to engine speed	Inadmissible fluid used	Drain fluid, refill with prescribed fluid, flush transmission while engine runs in neutral position, drain fluid, refill transmission
	Fluid contains water	Refer to 9.
	Shifting pressure too low	Refer to 6.
	Wear on clutch discs	Disassemble transmission, replace clutch discs
	Piston rings in clutch are damaged	Disassemble transmission, replace clutch
4. Transmission is blocked	Medium piston ring in input shaft in control block is faulty	Remove control block, replace piston ring, if control block is worn, replace likewise
	Dished discs due to overheating of slipping clutch	Refer to 3.
	Needle bearings on input shaft are worn out	Disassemble transmission, repair if possible or use substitute transmission
5. Output shaft turns in neutral position	Rotary slide valve in control block is worn	Replace control block
	Faulty needle bearing on input shaft	Disassemble transmission and input shaft, replace bearing concerned and other damaged parts
	Dished discs due to overheating of slipping clutch	Refer to 3.

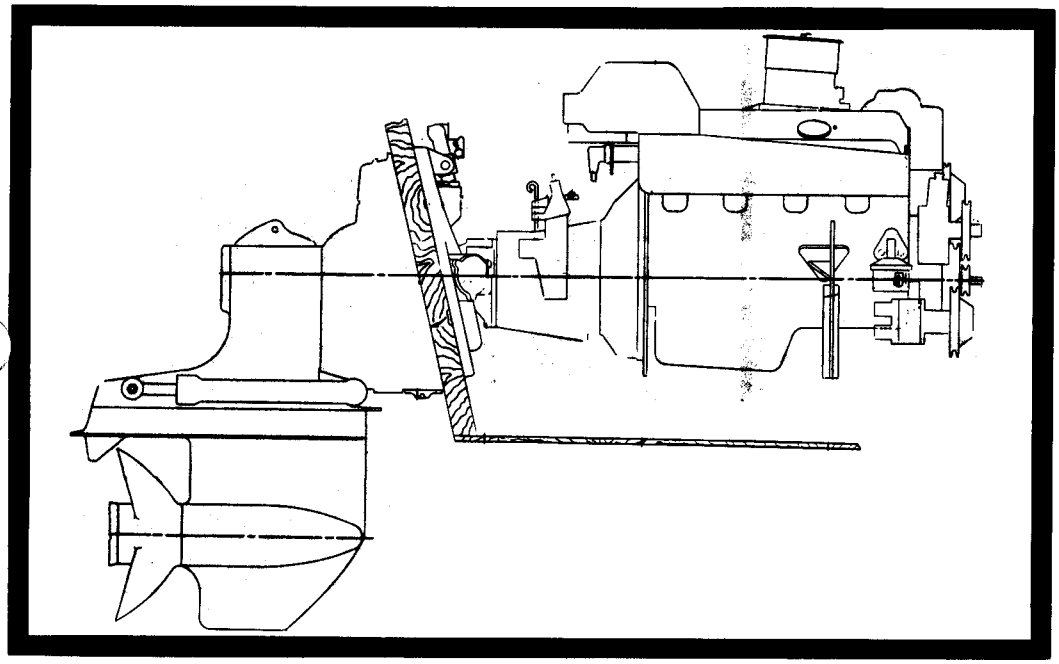
Trouble	Possible Cause	Remedy
6. Shifting pressure too low	Fluid filter dirty	Replace fluid filter
	Fluid level in transmission is too low	Fill with fluid; in case of fluid loss check transmission, cooler and pipelines for leakage and remedy same; also refer to 10 through 13
	Fluid pump is worn out	Replace control block together with fluid pump
	Piston rings in input shaft in control block are faulty	Remove control block and replace piston rings. In case of wear in control block due to faulty piston rings replace block as well
	Piston rings in clutch are faulty	Disassemble transmission, replace clutch
7. No shifting pressure available	Direction of engine rotation does not agree with arrow on transmission	Replace with L.H. rotation engine
	No fluid in the transmission	Refill with fluid
	Fluid filter is dirty	Replace fluid filter
	Fluid level in transmission is too low	Top-up with fluid. In case of loss of fluid check transmission, cooler and pipelines for leakage and remedy same, also refer to 10-13
	Fluid pump worn out	Replace control block together with fluid pump.
	Fitting key in input shaft for fluid pump drive is broken	Remove control block. Replace fitting key, replace any other faulty parts
	Spring of shifting pressure relief valve is broken	Replace control block
8. Excessive fluid temperature	Excessive fluid in transmission	Remove excessive fluid with commercial suction pump
	Fluid cooler is dirty on water side	Detach coolant water lines and clean fluid cooler on water side
	Worn fluid pump in control block	Replace control block together with fluid pump
	Faulty piston rings in input shaft in control block	Remove control block, replace piston rings in input shaft. In case of wear in the control block due to faulty piston rings replace control block as well
	Clutch is slipping	Refer to 3.
	Clutch does not open completely due to worn disc supports	Dismount transmission and coupling, replace all faulty parts
	Clutch does not open completely due to broken cup springs	Disassemble transmission, replace inner disc support and/or clutch
	Low water flow from sea pump	Repair or replace sea pump
9. Water in the fluid, fluid looks milky	Fluid cooler faulty	Repair leakage at cooler or replace cooler. Change transmission fluid
	High water level in engine compartment, water entering at output shaft seal	Remedy cause for water level in engine compartment, change transmission fluid

Trouble	Possible Cause	Remedy
10. Fluid leakage at input shaft	Breather clogged by paint or dirt	Remove paint or dirt from breather
	Shaft seal faulty	Disassemble transmission, replace seal. If seal location on input shaft is worn, repair surface
11. Fluid leakage at output shaft	Breather clogged with paint or dirt	Remove paint or dirt from breather
	Shaft seal faulty	Disassemble transmission, replace seal. If seal location on input shaft is worn, repair surface
12. Fluid leakage at venting filter	Excessive fluid in transmission	Pump excessive fluid out with commercial hand pump
13. Fluid leakage at joints or screw connections	Bolts are not tight	Tighten bolts to prescribed torque
	Seals on bolts have been used for several times	Replace seals, tighten bolts to prescribed torque
14. Fluid leakage at filter cap or breather	Filler cap not flush or tight	Reinstall filter cap flush with housing and tighten
	Filter cap O-ring damaged	Replace O-ring
	Fluid level too high	Correct Fluid level
15. Transmission noise changes, becomes louder	Fluid level too low so that pump sucks in air	Top up with fluid to marking on dipstick
	Damage starting on flexible coupling due to wear or fatigue, possibly due to misalignment between engine and transmission	Replace flexible coupling. Check alignment between engine and transmission
	Beginning damage of bearings in transmission, e.g. due to torsional vibrations, running without fluid, overload, wrong alignment of transmission, excessive motor output	Disassemble transmission, replace bearings concerned and other faulty parts. Find causes and remedy
	Beginning damage of gearings, e.g. due to torsional vibrations, running without fluid, overload	Disassemble transmission, remove faulty parts
	Fluid baffle on transmission has come loose	Disassemble transmission, attach baffle plate
	Fluid suction pipe in transmission has come loose	Disassemble transmission, fix fluid suction pipe
16. Chattering transmission noise mainly at low engine speed	The engine or propeller generate torsional vibrations which produce a "chattering" noise in the transmission	Mount a flexible coupling with another stiffness factor between engine and transmission; a coupling with a higher stiffness factor might be sufficient
	Misaligned carden shafts on input or output	Mount and align cardan shafts strictly according to instructions issued by cardan shaft manufacturer

REMOVAL and INSTALLATION

2

A



MCM Models with Alpha One Drives

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Attaching/Adjusting Throttle Cable	2A-5

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Drive Unit Shift Cable		
Brass Barrel	Spread Cotter Pin	
Cable End Guide	(Note 1)	
Front Engine Mount	Securely	
Hose Clamps	Securely	
Power Steering Fluid Hose Fittings		
Large	20-25 (27-34)	
Small		96-108 (11-12)
Rear Engine Mounts	35-40 (47-54)	
Remote Control Shift Cable		
Brass Barrel	Securely	
Cable End Guide	(Note 1)	
Remote Control Throttle Cable		
Brass Barrel	Securely	
Cable End Guide	(Note 1)	

NOTE: Tighten, then back nut off 1/2 turn.

TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Marine-Lube

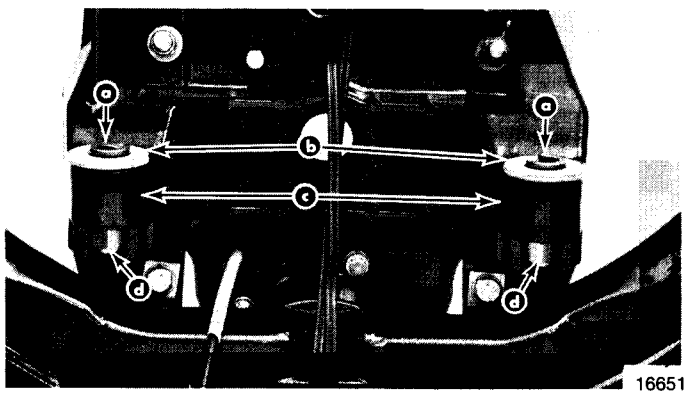
Removal

IMPORTANT: Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual".

1. Disconnect battery cables from battery and remove instrument harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Disconnect trim position sender wires (coming from gimbal housing) from terminal block on circuit breaker/solenoid mounting bracket. After wires are disconnected, remove wires from clamps that hold the power steering hoses.
4. Remove red and black Power Trim pump motor wires from engine (some models).
5. Disconnect water inlet hose and exhaust elbow bellows.
6. Remove both shift cables from shift plate.
7. Disconnect any grounding wire or accessories that are connected to the engine.
8. **Power Steering Models:** Disconnect fluid hoses from power steering control valve.
9. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.
10. Carefully remove engine.

Installation

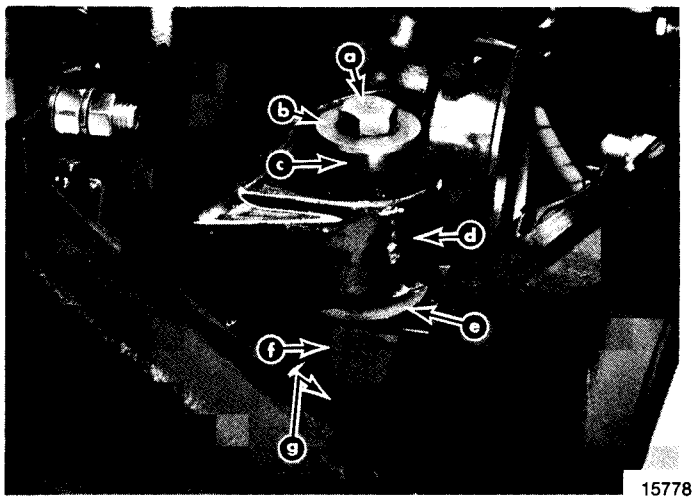
1. Lift engine with an overhead hoist, using suitable sling and lifting eyes on engine.
2. Lubricate engine coupling splines with 2-4-C Marine-Lube.
3. Place large fiber washer on top on transom plate engine mounting bracket and double wound lockwasher inside fiber washer.



16651

a - Double Wound Lockwasher
b - Fiber Washer
c - Mounting Bracket
d - Elastic Stop Nuts (Engine Mounting Bolts)

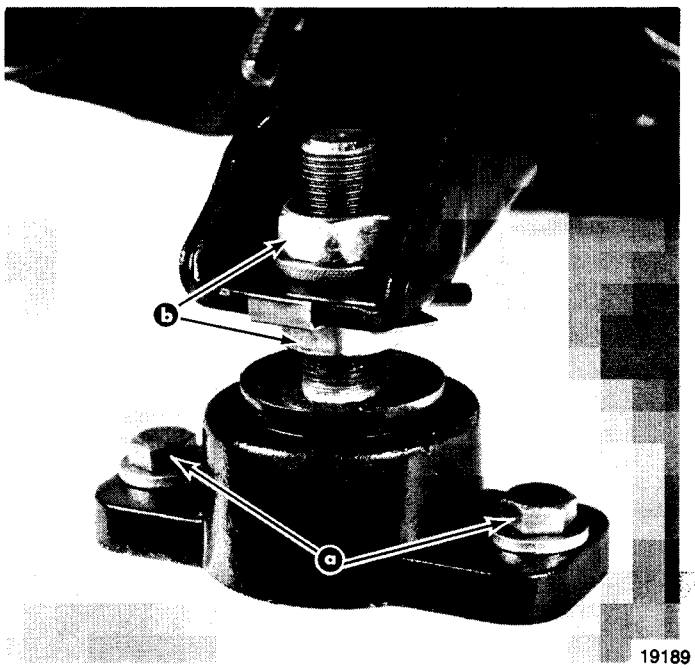
4. Place engine over transom plate mounting brackets. hose clamps over rubber exhaust elbow bellows.
5. Place steel washers and spacers on mounting bolts and insert bolts down thru rear engine mounts, washers and mounting brackets. Thread elastic stop nuts on bolts. Torque to specification.



15778

a - Rear Engine Mounting Bolts
b - Large Steel Washer
c - Metal Spacer
d - Rear Engine Mount
e - Fiber Washer With Double Wound Lockwasher in the Center
f - Mounting Brackets
g - Elastic Stop Nut (Hidden)

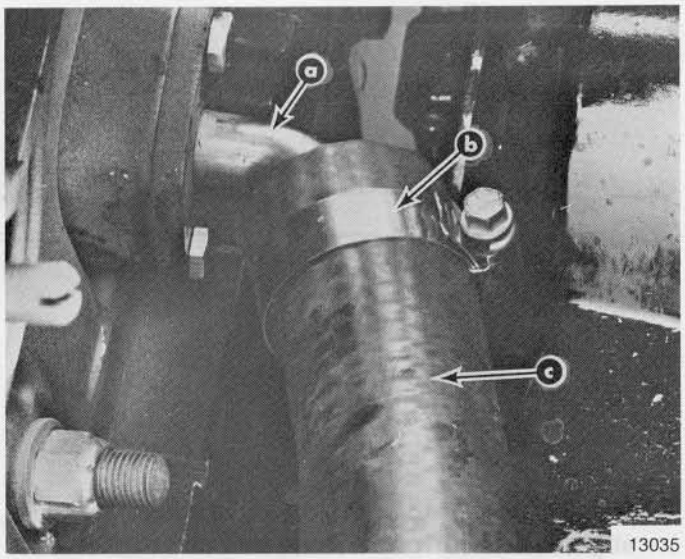
6. Tighten all exhaust bellow clamps securely.
7. Secure front engine mounts to boat.
8. Check engine alignment. Refer to "Alignment". After correct alignment is attained, tighten locknuts securely.



19189

a - Mounting Bolts
b - Locking Nuts

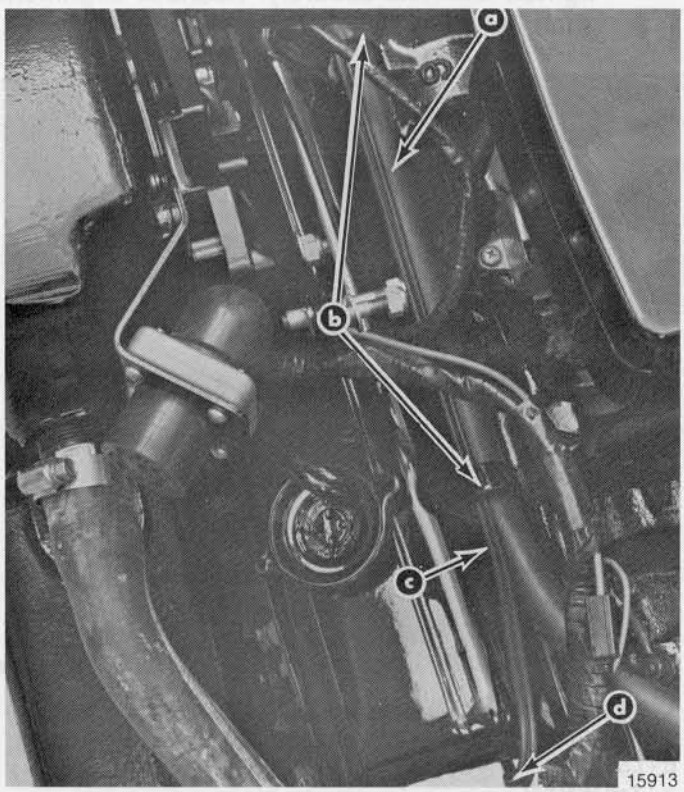
9. Place hose clamp over water inlet hose and place hose over inlet tube. Tighten clamp securely.



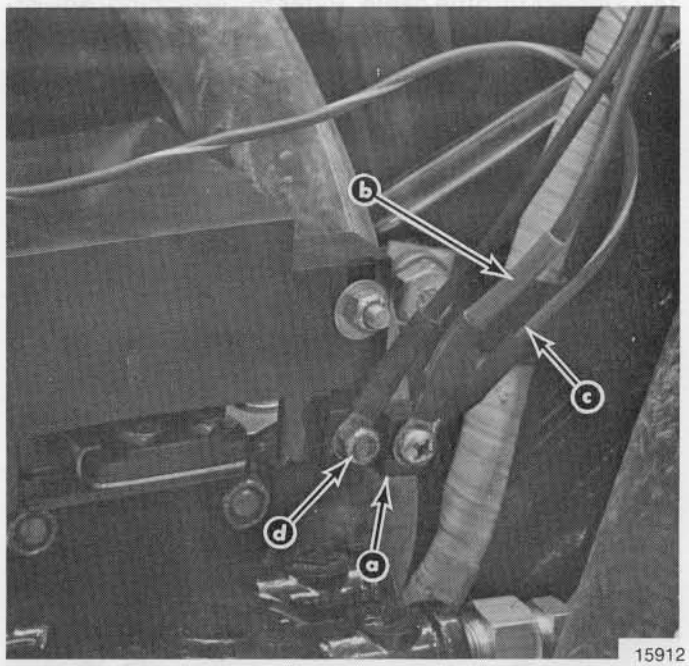
a - Water Inlet Tube
b - Hose Clamp
c - Water Inlet Hose

10. Connect instrument harness to engine harness. Secure with clamp and tighten securely.

11. Conect trim position sender wires as follows:



a - Power Steering Hydraulic Hose
b - Hose Clips
c - Trim Position Sender Wires (Route Thru Hose Clips)
d - Sta-Strap Leads at This Location

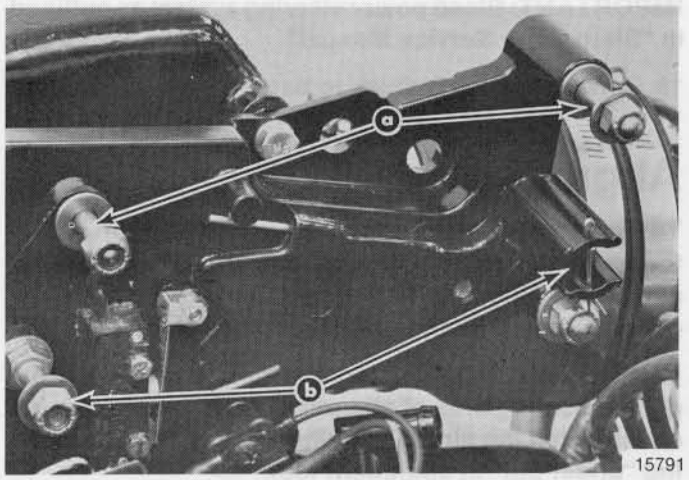


a - Terminal Block
b - Brown or Purple Sleeve — To Insulated
c - Brown/White Wire — Terminal
d - Without Sleeve - To Terminal Block Mounting Screw

12. Connect fuel line. Check for fuel leaks.

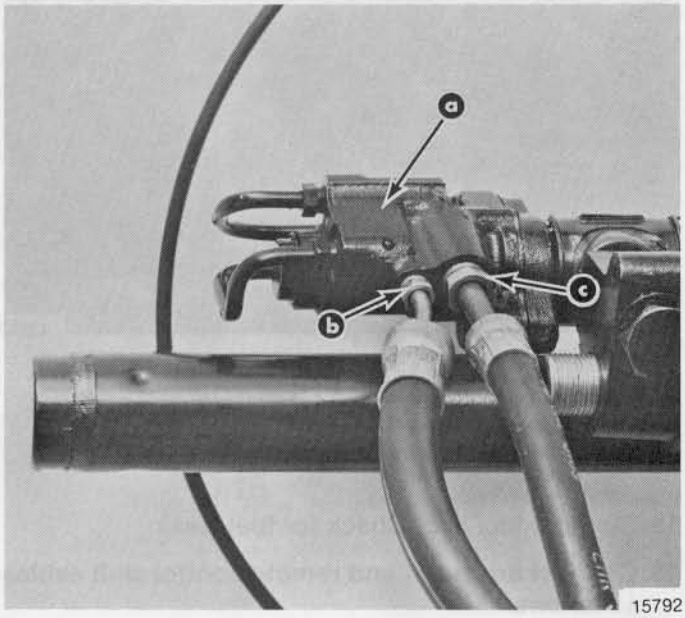
13. Connect drive unit and remote control shift cables as follows:

IMPORTANT: Adjust shift cables as outlined in "Stern Drive Service Manual".



a - Remote Control Shift Cable Anchor Points
b - Drive Unit Shift Cable Anchor Points

14. Connect throttle cable. Refer to "Attaching/Adjusting throttle Cable".
15. Connect red and black trim pump wires (some models).
16. Connect any ground wires or accessories that may have been disconnected.
17. **Power Steering Models:** Reconnect fluid hoses as shown.



15792

a - Control Valve
b - Small Fitting
c - Large Fitting
Torque to Specifications

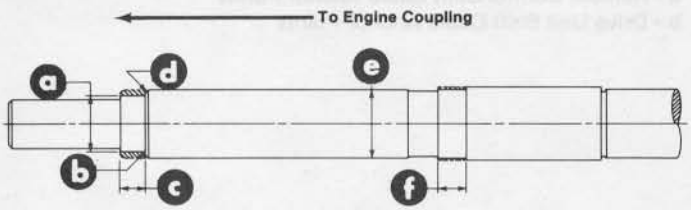
IMPORTANT: Bleed power steering system as outlined in "Stern Drive Service Manual".

18. Connect battery cables to battery.

Alignment

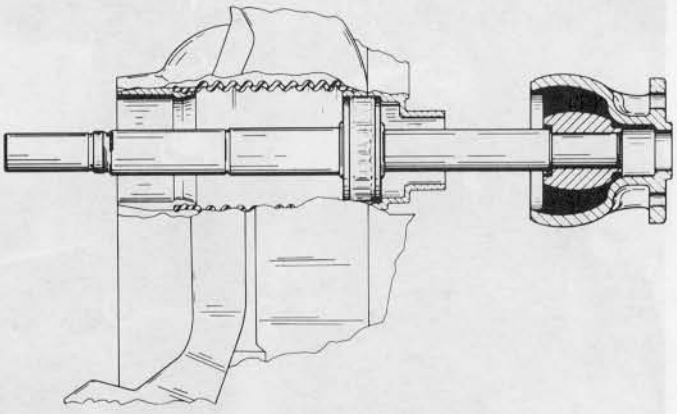
To ensure more engine coupler engagement during the alignment of engines, modify the alignment tool as shown. This modification will improve engine engagement on the other model engines also.

IMPORTANT: DO NOT remove more than .560" from gimbal bearing area of alignment tool. This dimension ensures that the gimbal bearing will straddle the existing "under cut" in alignment tool.



a - 1.150" Dia.
b - .06" R. Permissible
c - .500"
d - .06 x 45° Chamfer
e - 1.374" - 1.376" Dia.
f - .560

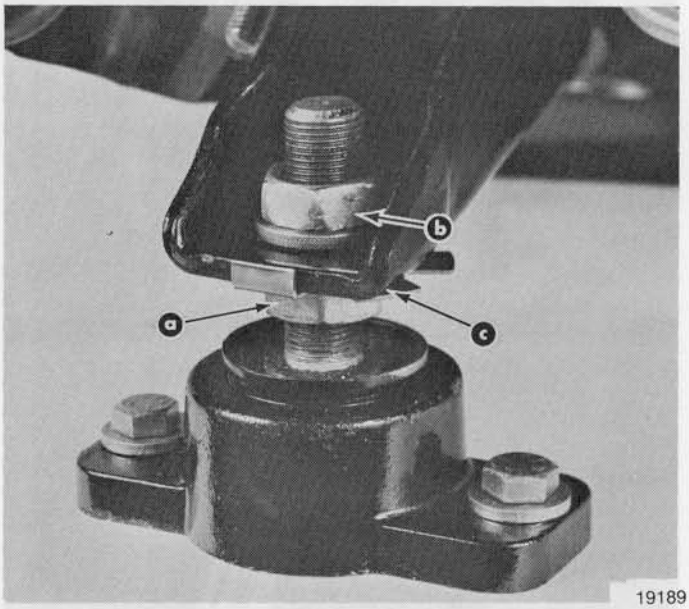
1. Using Alignment Tool (91-57797A3), insert end of shaft (which does not have threaded hole) thru gimbal bearing. Move gimbal bearing, as required, to insert shaft into engine coupling.



2. If shaft enters coupling freely with no pressure, alignment is correct. If not, proceed as follows:
   a. Loosen locknut on both front engine mounts.
   b. Thread adjusting nut either way to raise or lower front of engine.

IMPORTANT: Raise or lower each side of the engine the same amount. Care must be taken not to "cock" front of engine.

   c. After correct alignment shaft fit is attained, tighten locknuts securely. Recheck alignment shaft fit.



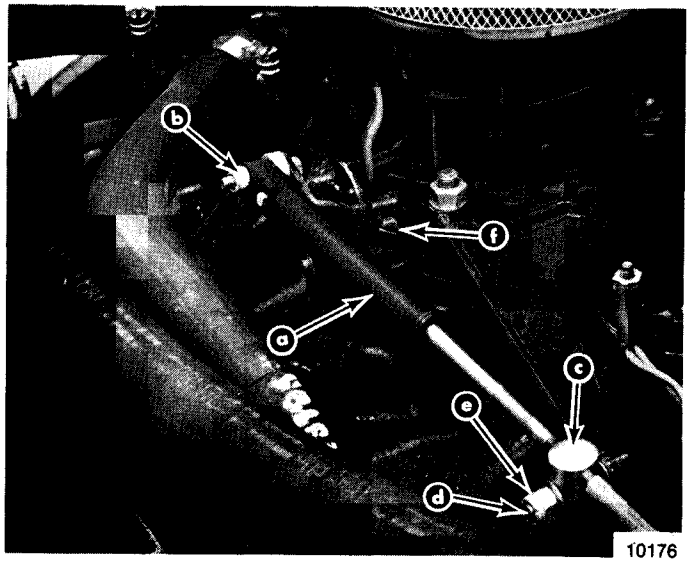
19189

a - Turn both Front Engine Mounts an Equal Amount in Direction Required Until Alignment Shaft Enters Engine Coupling Freely
b - Locknut
c - Tab Washer

Attaching/Adjusting Throttle Cable

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel as shown.

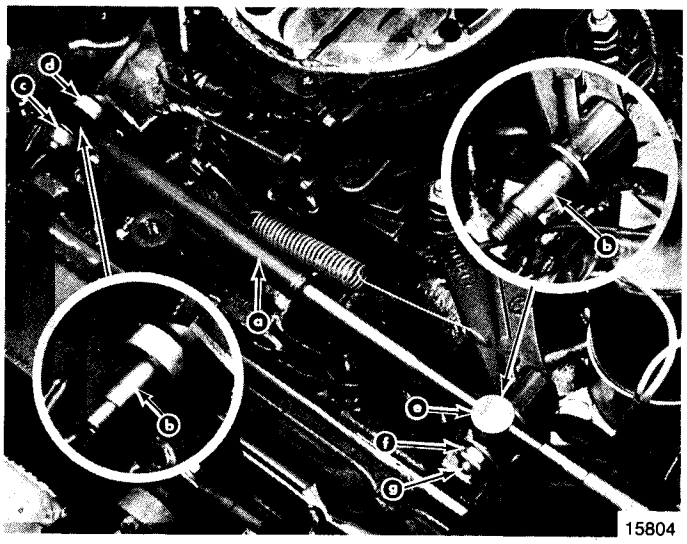
MODEL WITH 2 BARREL CARBURETOR



10176

a - Cable End Guide
b - Washer, Nut, Screw and Bushing (DO NOT Over-Tighten)
c - Brass Barrel
d - Stud
e - Washer and Nut (DO NOT Over-Tighten)
f - Idle Stop Screw

MODELS WITH 4 BARREL CARBURETOR

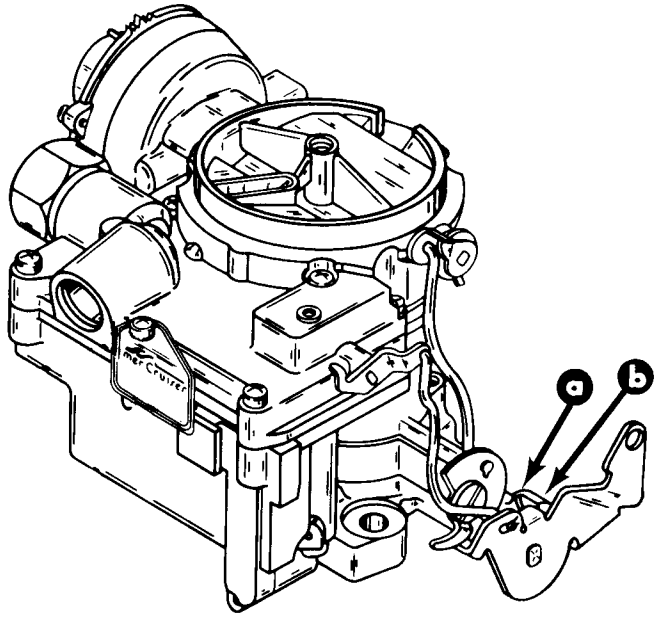


15804

a - Cable End Guide
b - Bushing
c - Washer, Nut and Screw (DO NOT Over-Tighten)
d - Spacer
e - Brass Barrel
f - Washer and Nut (DO NOT Over-Tighten)
g - Anchor Stud

4. Check that throttle valves are fully open when remote control is at full throttle position. Level tang should be against stop as shown in Figure 3 or 4.
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop.

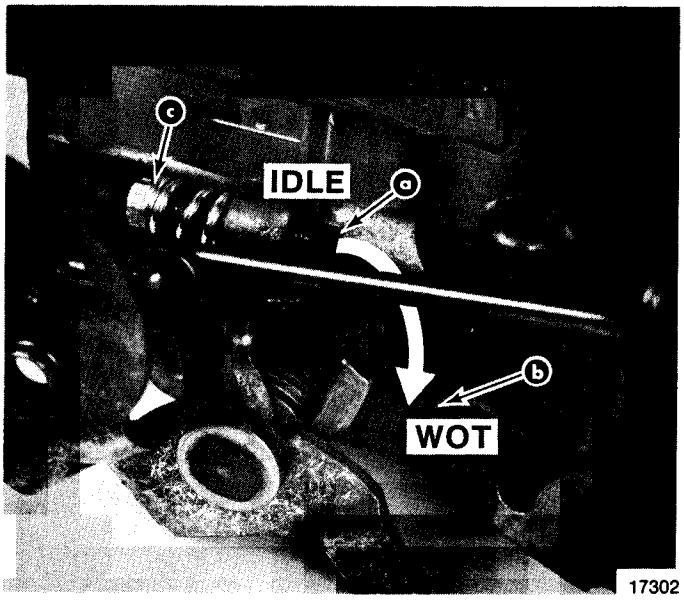
MODEL WITH 2 BARREL CARBURETOR



392-H

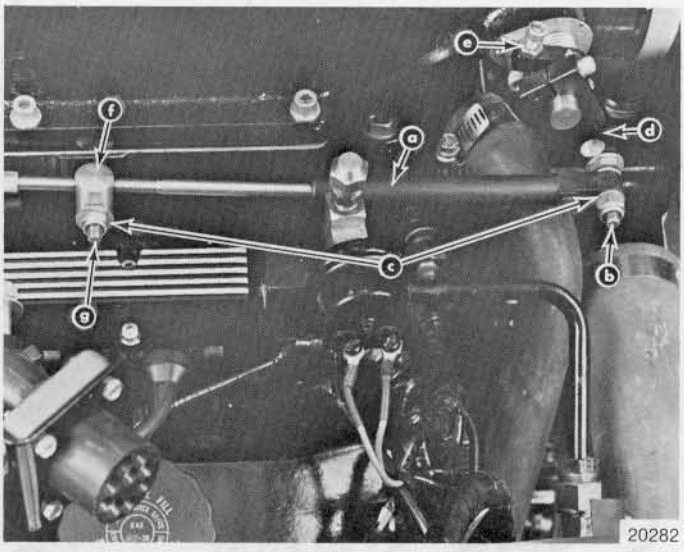
a - Throttle Lever Tang Against Stop
b - Idle Stop Screw

MODELS WITH 4 BARREL CARBURETOR



17302

a - Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

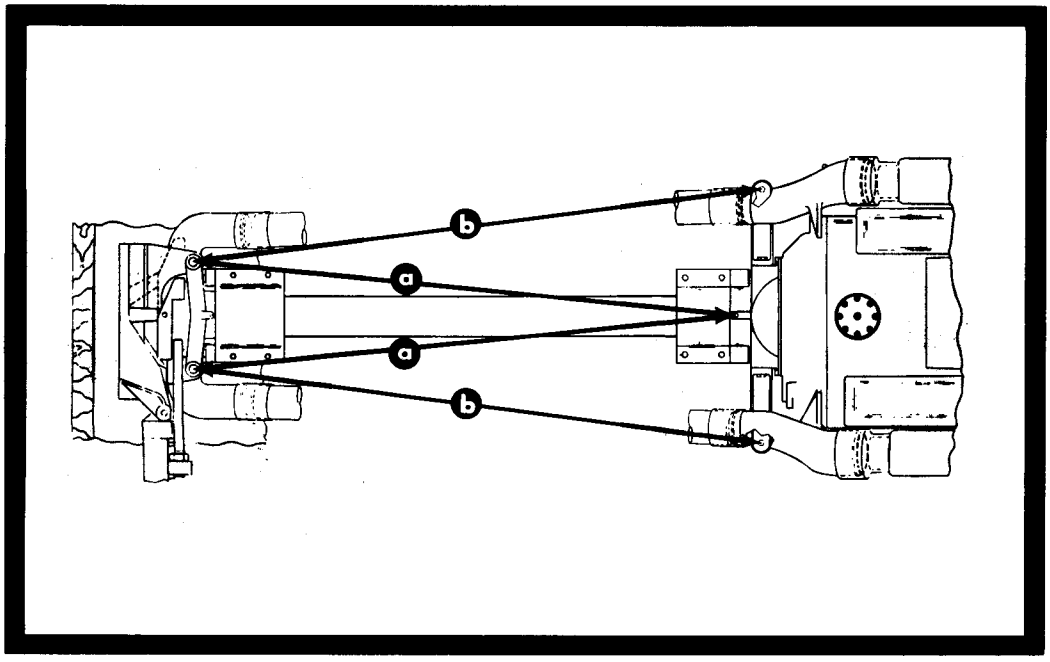


a - Cable End Guide
b - Throttle Lever Stud
c - Elastic Stop Nut and Flat Washer
d - Throttle Lever
e - Idle Speed Adjustment Screw (Must Contact Idle Speed Stop Screw)
f - Brass Barrel
g - Throttle Cable Anchor Stud

REMOVAL and INSTALLATION

2

B



MCM MODELS with I DRIVE with DRIVESHAFT EXTENSION

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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Battery Cables	Securely
Bearing Support to Inner Transom Plate	35-40 (47-54)
Drive Shaft	50 (68)
Drive Shaft Shield	30 (41)
Extension Housing to Flywheel Housing	30 (41)
Flywheel Housing	30 (41)
Front and Rear Engine Mounts	Securely
Hose Clamps	Securely
Rear Engine Mount Bracket	50 (68)
Remote Control Throttle Cable Brass Barrel Cable End Guide	 Securely (Note 1)

NOTE 1: Tighten, then back nut off 1/2 turn.

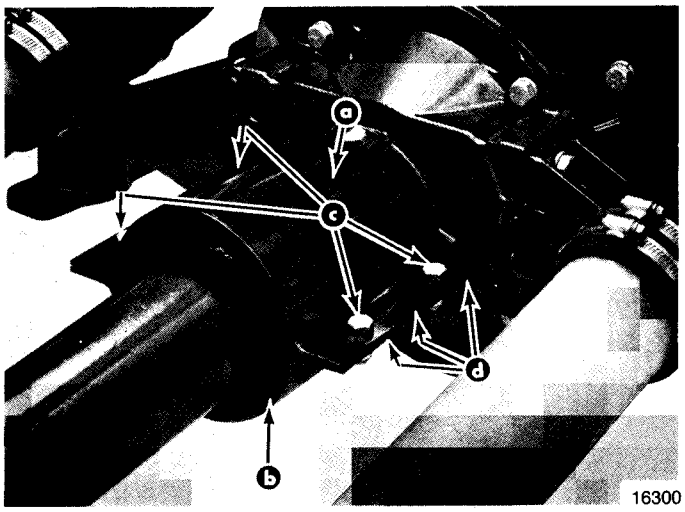
TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Marine-Lube

Removal

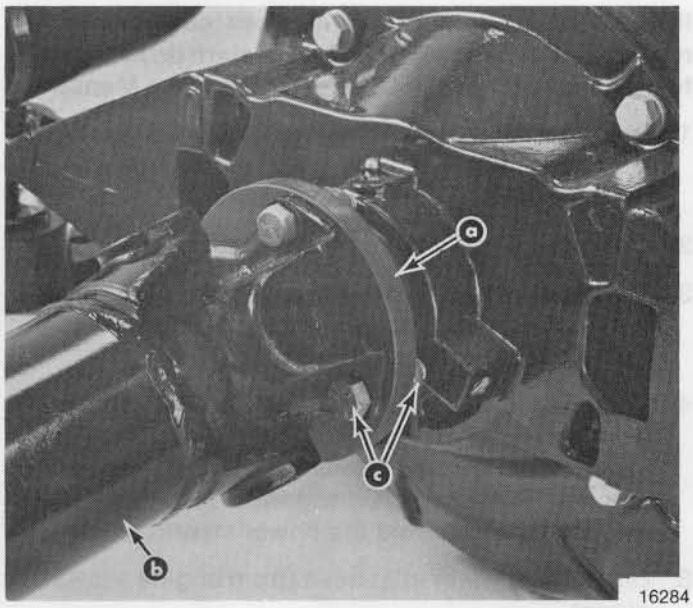
IMPORTANT: Stern drive unit does not have to be removed prior to engine removal. If stern drive is going to be removed, refer to "Stern Drive Service Manual".

1. Disconnect battery cables from battery and remove instrument harness plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Slide sleeves back on black and white/green (or gray) wires and disconnect engine harness wires from shift cut-out switch harness.
4. Disconnect trim position sender brown/white wire from terminal block on engine. Terminal block located on circuit breaker/solenoid mounting bracket. After wires are disconnected, remove wires from clamps that hold the power steering hoses.
5. Disconnect water inlet hose (from engine seawater pump).
6. Disconnect exhaust pipes from exhaust hoses.
7. Remove top shield and then bottom shield.



a - Top Shield
b - Bottom Shield
c - 4 Screws/Nuts (2 Hidden)
d - 3 Screws (Hidden)

8. Disconnect drive shaft from output flange.



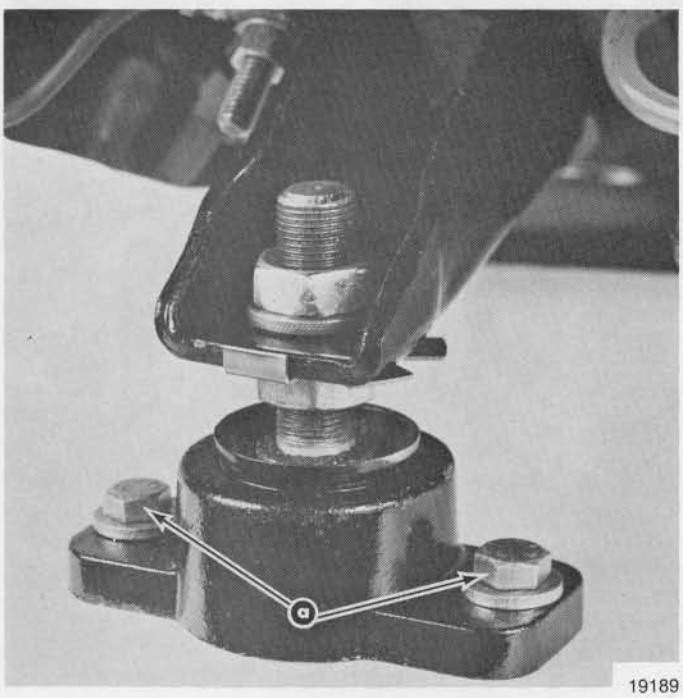
16284

a - Output Flange
b - Drive Shaft
c - Screw/Nut (4)

9. Disconnect fluid hoses from power steering control valve (located on transom plate).
10. Disconnect any grounding wire or accessories that are connected to the engine.

IMPORTANT: To avoid the need for a complete realignment (after engine repair), do not move front or rear mounts. Remove mounting bolts.

11. Support engine with suitable sling thru lifting eyes on engine and remove front and rear mounting bolts.
12. Carefully remove engine.



19189

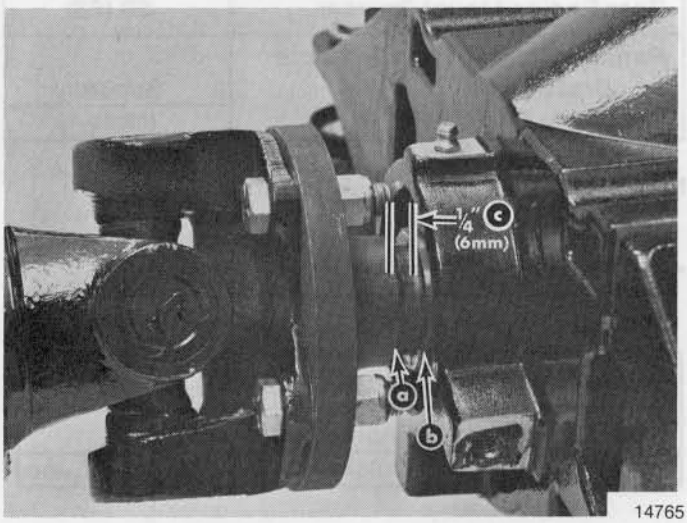
a - Mounting Bolts

Installation

IMPORTANT: If engine mounts or drive shaft have been changed, refer to "Alignment" before starting installation.

1. Lift engine with an overhead hoist, using suitable sling and lifting eyes on engine.
2. Set engine on stringers.
3. Connect drive shaft to output flange. Torque screws and nuts to specifications.
4. Relieve hoist tension from engine; then slide engine fore or aft as needed to obtain a 1/4" (6mm) between flange shoulder and extension shaft housing bearing.

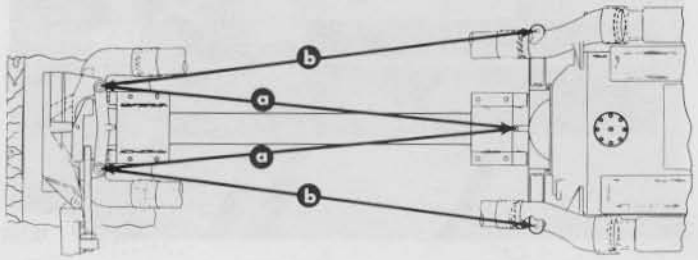
IMPORTANT: Failure to properly position output shaft flange may result in bearing damage.



14765

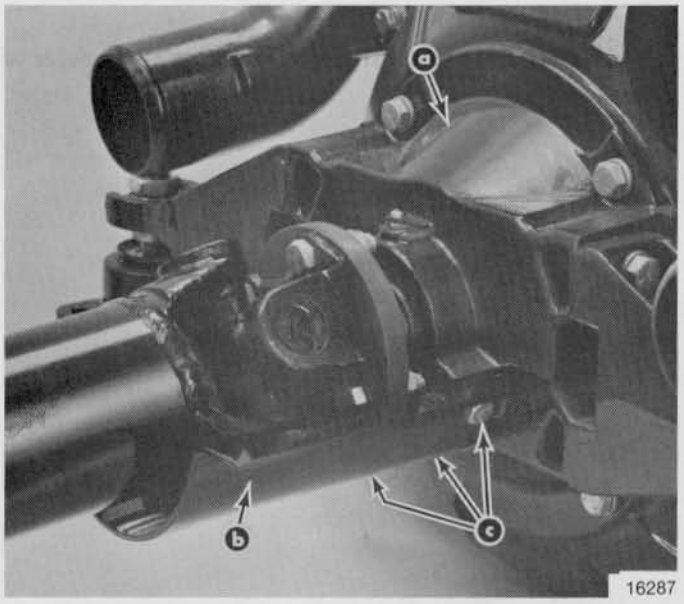
a - Flange Shoulder
b - Bearing
c - 1/4" (6mm)

5. Position engine for correct engine and drive shaft lateral alignment as follows:
   a. The distance between the center of the bearing support attaching bolts on inner transom plate and grease fitting on shaft extension housing must be equal. If not, slide aft end of engine to one side or the other until distances are equal.
   b. Measure distance between the center of the bearing support attaching bolts and rear engine mount adjusting bolt. These distances also must be equal. If not, slide front of engine to one side or the other until distances are equal.

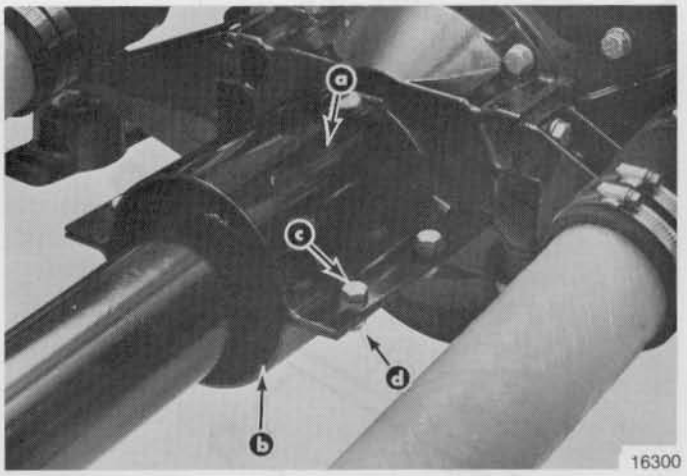


a - Distance Between Bearing Support Attaching Bolts and Grease Fitting
b - Distance Between Bearing Support Attaching Bolts and Engine Mount Bolts

6. After engine has been aligned correctly, fasten front and rear engine mounts to stringers.
7. Install top and bottom shield. Torque screws to specifications.

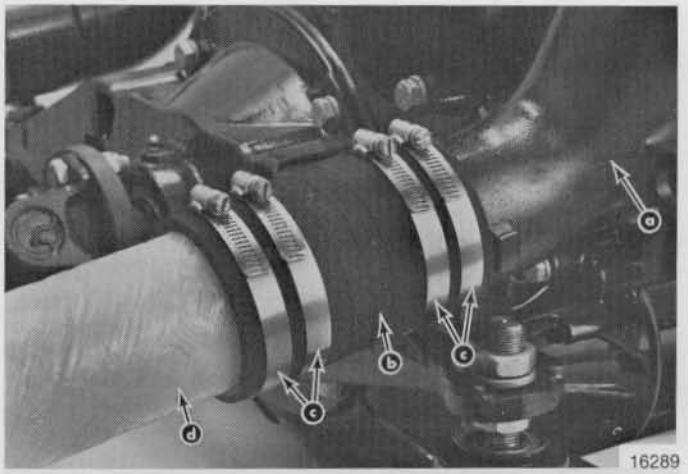


a - Shaft Housing
b - Bottom Shield
c - Screws (Threads of Screws Are Coated with Loctite)



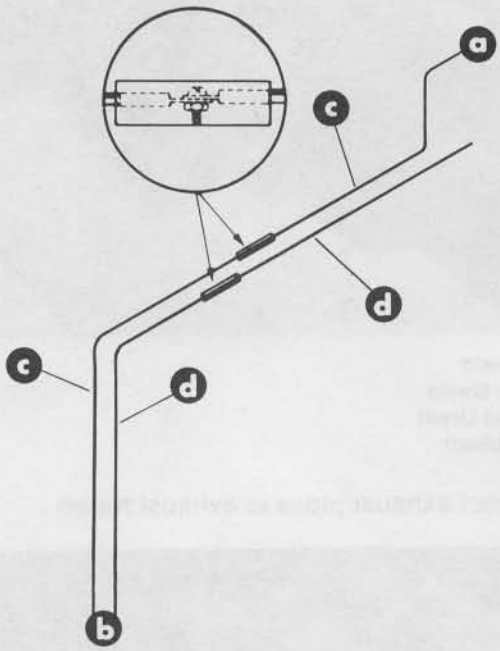
a - Top Shield
b - Bottom Shield
c - Screw (4 Used)
d - Nut (4 Used)

8. Connect exhaust pipes to exhaust hoses.



a - Exhaust Pipe
b - Exhaust Hose
c - Clamps (Tighten Securely)
d - Exhaust Tube

9. Connect water inlet hose to seawater pump.
10. Reconnect shift cut-out switch harness to engine harness.



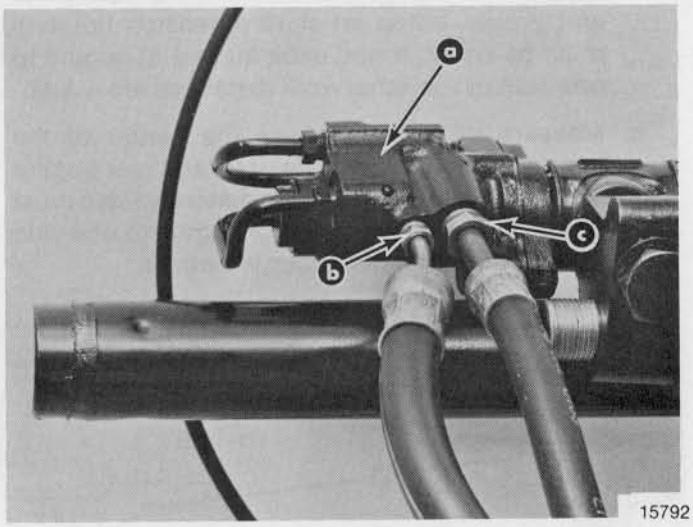
a - Engine Harness
b - Switch Harness
c - Black
d - White-Green (or Gray)

11. Connect instrument harness to engine harness. Tighten clamp.
12. Connect trim position sender brown/white wire as shown.

a - Brown/White Wire - Route Thru Clamps That Hold the Power Steering Hoses. Then Connect to Insulated Terminal

13. Reconnect power steering fluid hoses as shown.

IMPORTANT: Bleed power steering system as outlined in "Stern Drive Service Manual".



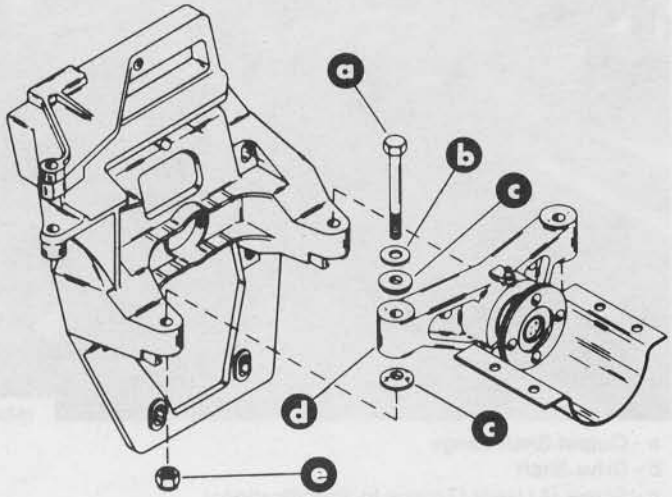
a - Control Valve
b - Small Fitting
c - Large Fitting
Torque to Specifications

14. Connect fuel line. Check for leaks.
15. Connect throttle cable. Refer to "Attaching/Adjusting Throttle Cable".
16. Connect any grounding wires or accessories that may have been disconnected.
17. Connect battery cables to battery.

IMPORTANT: If stern drive unit was removed, refer to "Alignment'.

Alignment

1. Install bearing support, as shown. Do not tighten bolts.



a - Bolt, Bearing Support (2)
b - Flat Washer (2)
c - Spherical Washer (4) (Install with Rounded Side Toward Bearing Support)
d - Bearing Support
e - Nut (2)

2. Insert solid end of Alignment Tool (91-57797A3) thru bearing in gimbal housing and into input shaft splines.

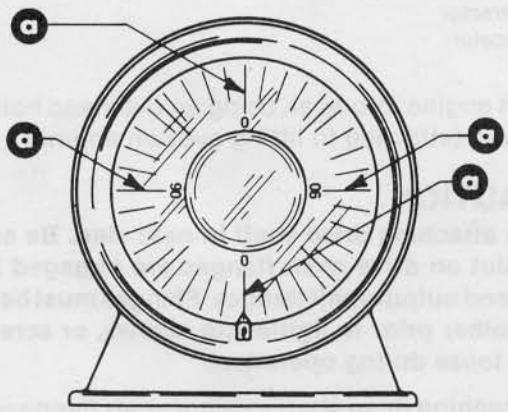
a - Alignment Shaft

3. Tighten bearing support bolts until snug [5-10 lbs. ft. (7-13 N.m)]. Strike the head of both bolts with a ball peen hammer, then torque bolts to specifications.

IMPORTANT: Bearing support attaching bolts must be struck with a hammer to properly seat spherical washers. If procedure is not followed, subsequent damage to bearings may occur from misalignment.

ALIGNMENT

IMPORTANT: A Universal Protractor is required for measuring the angles in the following steps. Protractor readings will be taken off of vertical and horizontal surfaces; therefore, both the 0° and the 90° marks will be used. It should be kept in mind that these are reference marks only and the actual numbers should be ignored. It is only necessary to note the number of degrees and to which side (left or right) of the reference marks the indicator needle rests. Protractor must be viewed from the same side of power package throughout alignment.

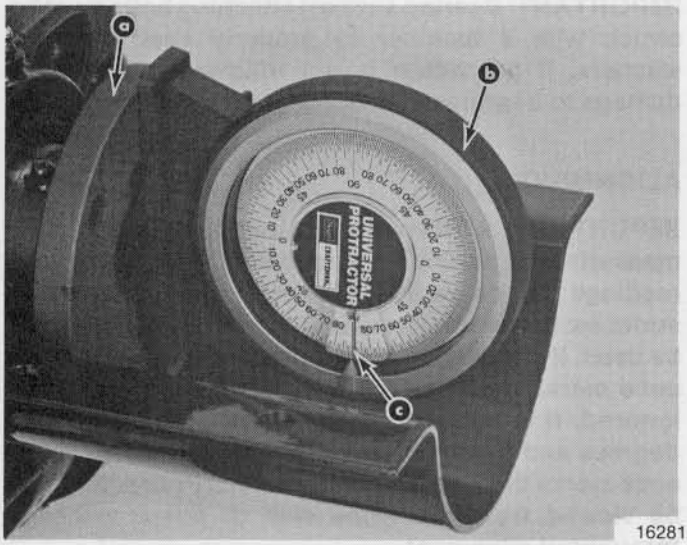


a - Protractor Reference Marks

1. Insert solid end of alignment tool thru bearing in gimbal housing and into bearing support input shaft splines.
2. Position base of protractor against input shaft flange, as shown. Note and record the number of degrees and to which side of the reference mark the indicator needle has moved in the chart following.

READING from STEP 2
_____ degrees to the
_____ side of Reference mark.

IMPORTANT: Be sure that boat does not move once reading has been taken from input shaft flange, as this reading establishes reference point for aligning drive shaft and engine following.



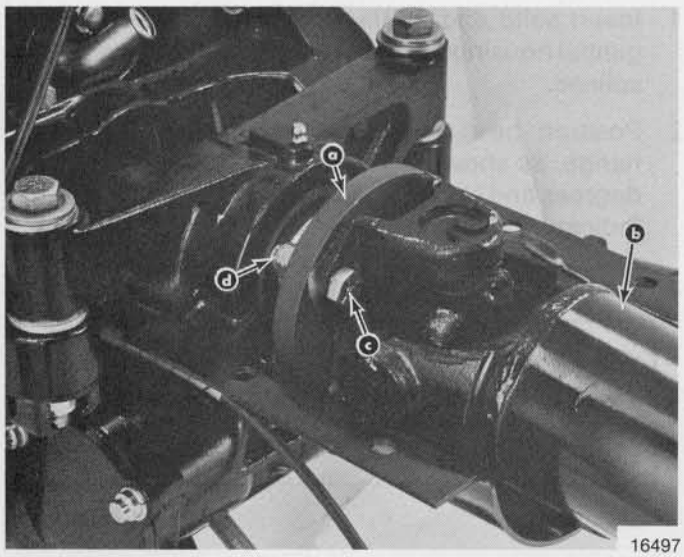
a - Input Shaft Flange
b - Protractor
c - Indicator

3. Lift engine into boat, using an overhead hoist and a chain (attached to lifting eyes on engine).

⚠CAUTION

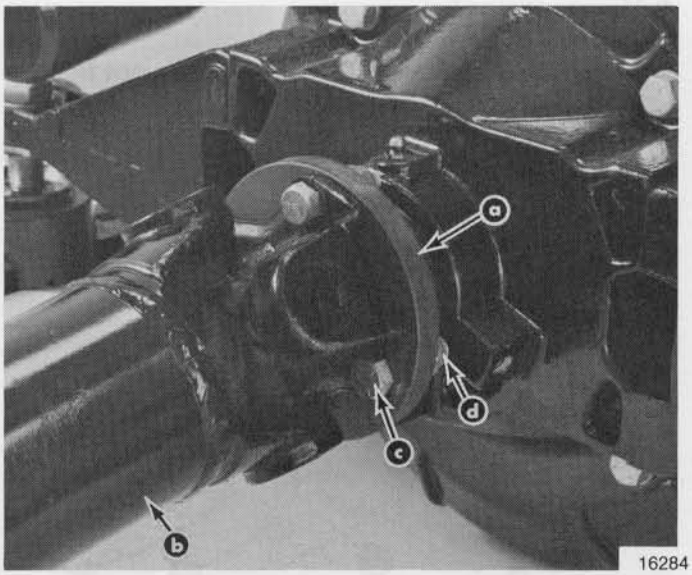
When attaching drive shaft in next step. Be sure that the pilot on drive shaft flanges are engaged in input shaft and output shaft flanges. Flanges must be flush to each other prior to tightening screws, or screws may come loose during operation.

4. Attaching drive shaft to input shaft flange and output shaft flange, as shown.



a - Input Shaft Flange
b - Drive Shaft
c - Screw (4 Used) (Torque to Specifications)
d - Nut (4 Used)

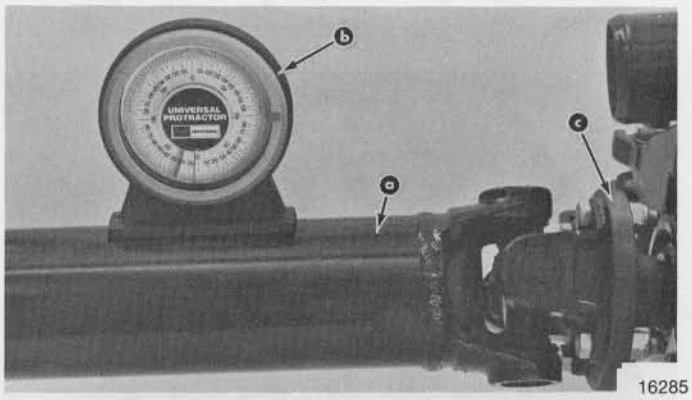
Drive Shaft Attached to Input Shaft Flange



a - Output Shaft flange
b - Drive Shaft
c - Screw (4 Used) (Torque to Specifications)
d - Nut (4 Used)

Drive Shaft Attached to Output Shaft Flange

5. Position base of protractor on drive shaft, then, adjust engine mounts so that indicator needle is 1° to 3° on either side of reading taken in Step 2. Record this reading in the following chart for later use.



a - Drive Shaft
b - Protractor
c - Output Shaft Flange

READING from STEP 5

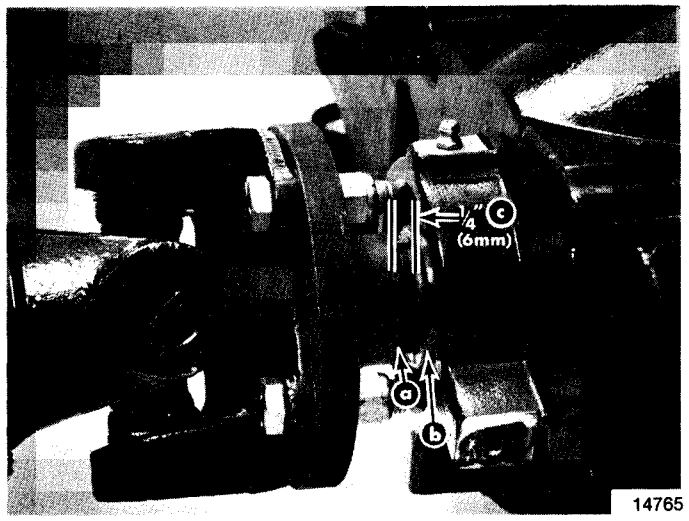
_____ degrees to the

_____ side of Reference mark.

IMPORTANT: A minimum of 1/4" (6mm) up-and-down engine mount adjustment must exist after engine has been properly aligned. This is necessary to allow for realignment of the engine in the future. If mount travel is insufficient, boat stringer height must be adjusted.

IMPORTANT: Failure to properly position engine (as described following) may result in bearing damage.

6. Relieve hoist tension from engine, then slide engine fore or aft as needed to obtain a 1/4" (6mm) between flange shoulder and extension shaft housing bearing, as shown.



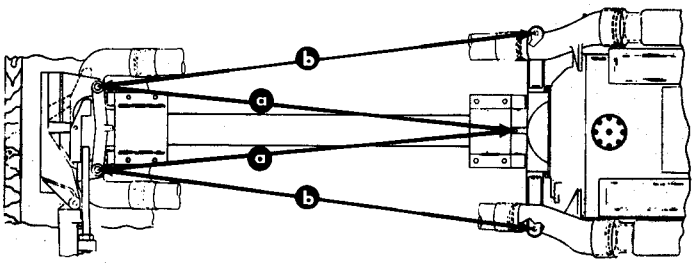
14765

a - Flange Shoulder
b - Bearing
c - 1/4" (6mm)

⚠CAUTION

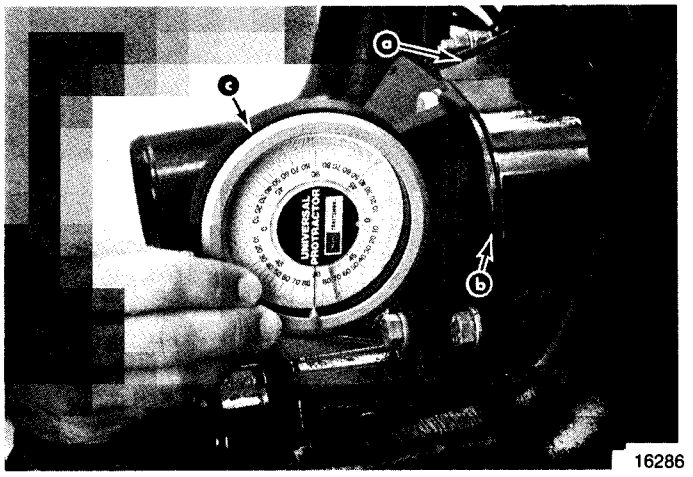
Engine must be aligned correctly to achieve proper engine operation and to prevent damage to drive shaft. If drive shaft is run at an incorrect angle, damage to universal joint bearings may result.

7. Position engine for correct engine and drive shaft lateral alignment as follows:
   a. The distance between the center of the bearing support attaching bolts (on inner transom plate) and grease fitting on shaft extension housing must be equal. If not, slide aft end of engine to one side or the other until distances are equal.
   b. Measure distance between the center of the bearing support attaching bolts and rear engine mount adjusting bolt, as shown. These distances also, must be equal. If not, slide front of engine to one side or the other until distances are equal.



a - Distance Between Bearing Support Attaching Bolts and Grease Fitting
b - Distance Between Bearing Support Attaching Bolts and Engine Mount Bolts

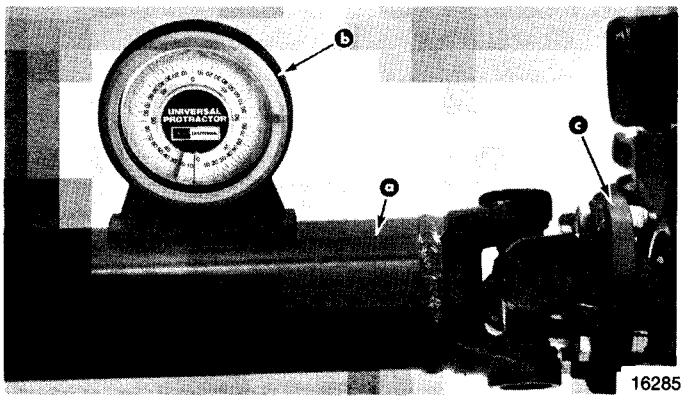
8. After engine has been aligned correctly, fasten front and rear engine mounts to stringers.
9. Position protractor on starter housing cover plate, as shown. Raise or lower front engine reads exactly the same number of degrees as that recorded in Step 2.



16286

a - Flywheel Housing
b - Starter Housing Cover Plate
c - Protractor

10. Position protractor on drive shaft as shown and recheck angle. Angle should be the same as that recorded in Step 5. If not, raise or lower all engine mount adjusting nuts an equal amount until correct angle is reached.



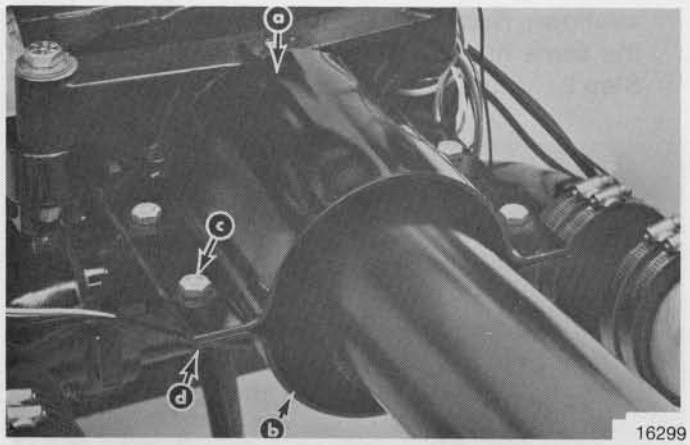
16285

a - Drive Shaft
b - Protractor
c - Output Shaft Flange

11. Tighten all engine mount locking nuts securely.
12. Remove alignment shaft from gimbal housing.

13. Install drive shaft shields.

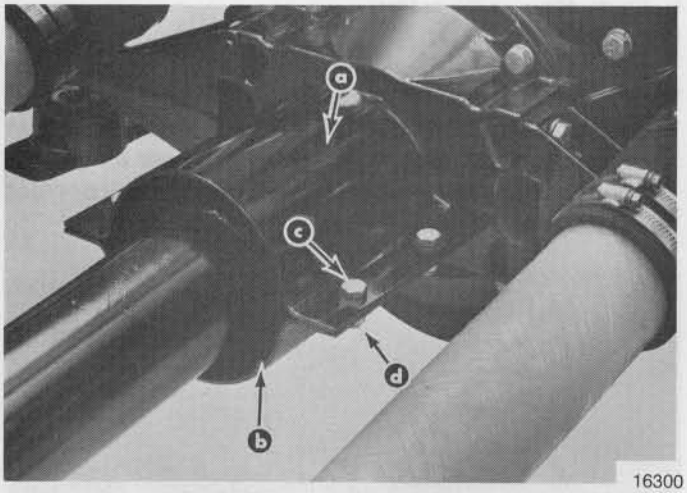
Transom End



16299

a - Top Shield
b - Bottom Shield
c - Screw (4 Used)
d - Nut (4 Used) (Torque to Specifications)

Engine End

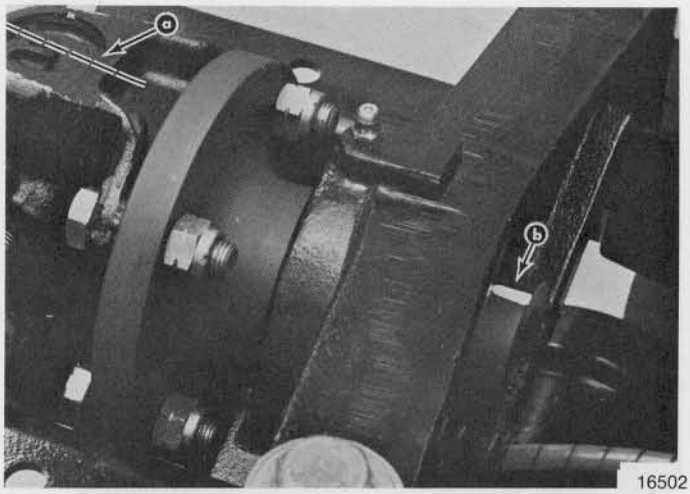


16300

a - Top Shield
b - Bottom Shield
c - Screw (4 Used)
d - Nut (4 Used) (Torque to Specifications)

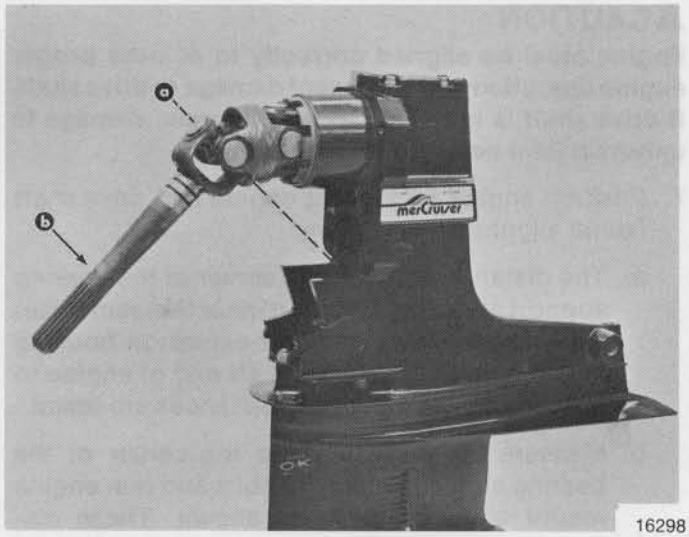
14. Install stern drive unit. Stern drive unit installation procedure is the same as that for the standard models, with the following exceptions: No alignment is necessary, other than to align gimbal bearing with bearing support input shaft. Steps 2 and 3.

IMPORTANT: Stern drive universal joints must be aligned with drive shaft universal joints, as shown. Place a reference mark (white paint) on shafts to correspond with universal joint centerlines. After installing stern drive, check to ensure that these marks are in alignment.



16502

a - Imaginary Centerline Running Thru This Universal Joint Bearing Must Be Vertical
b - Place a Reference Mark Here To Correspond with "a"



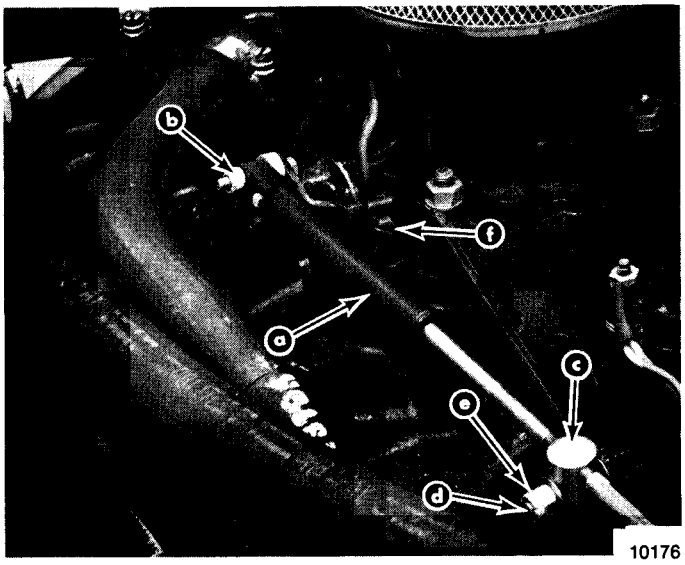
16298

a - Imaginary Centerline Running Thru This Universal Joint Bearing Must Be Vertical (Once Drive Unit is Installed)
b - Place a Reference Mark Here To Correspond with "a"

Attaching/Adjusting Throttle Cable

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel as shown.

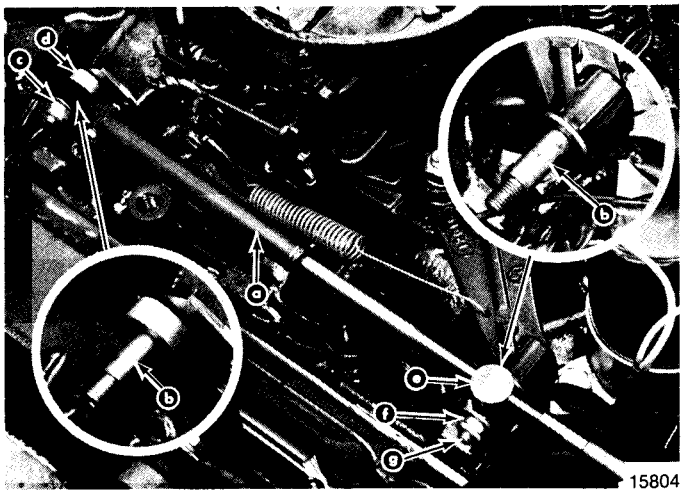
MODEL WITH 2 BARREL CARBURETOR



10176

a - Cable End Guide
b - Washer, Nut, Screw and Bushing (DO NOT Over-Tighten)
c - Brass Barrel
d - Stud
e - Washer and Nut (DO NOT Over-Tighten)
f - Idle Stop Screw

MODELS WITH 4 BARREL CARBURETOR

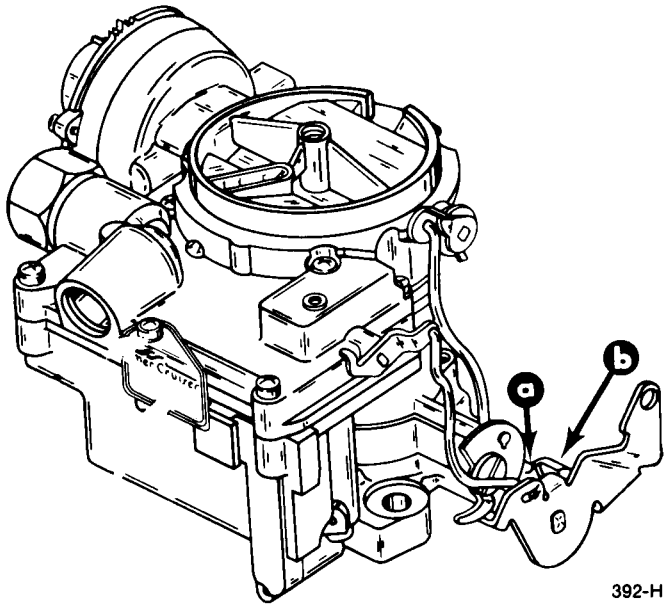


15804

a - Cable End Guide
b - Bushing
c - Washer, Nut and Screw (DO NOT Over-Tighten)
d - Spacer
e - Brass Barrel
f - Washer and Nut (DO NOT Over-Tighten)
g - Anchor Stud

4. Check that throttle valves are fully open when remote control is at full throttle position. Level tang should be against stop as shown in Figure 3 or 4.
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop.

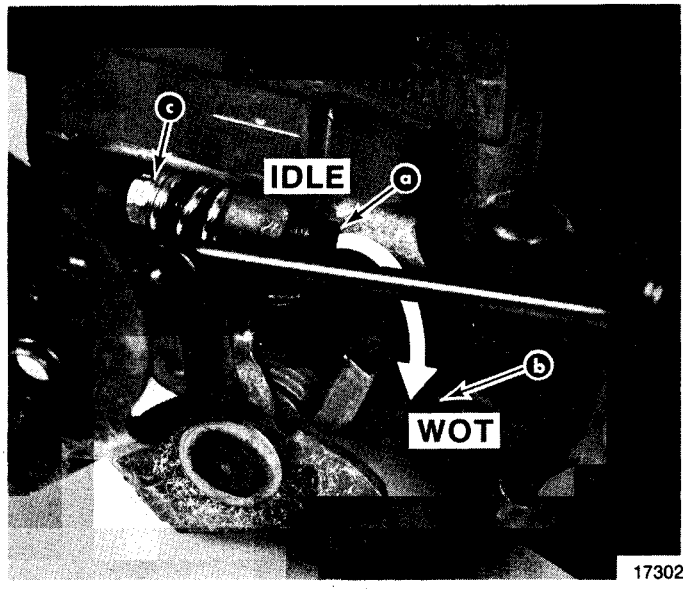
MODEL WITH 2 BARREL CARBURETOR



392-H

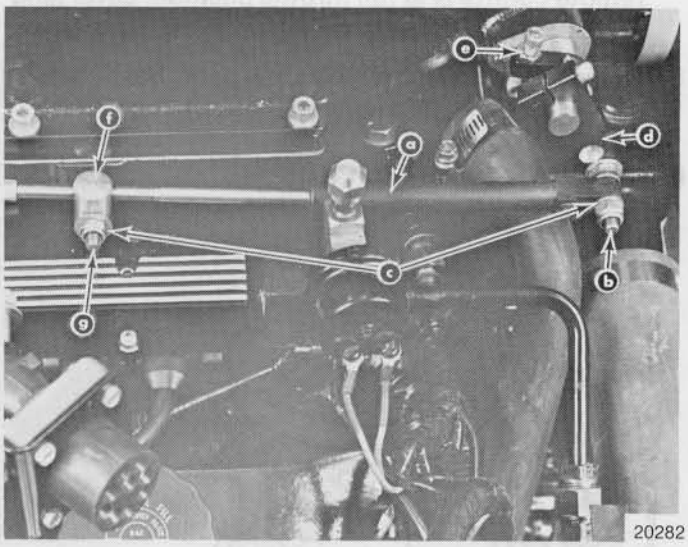
a - Throttle Lever Tang Against Stop
b - Idle Stop Screw

MODELS WITH 4 BARREL CARBURETOR



17302

a - Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

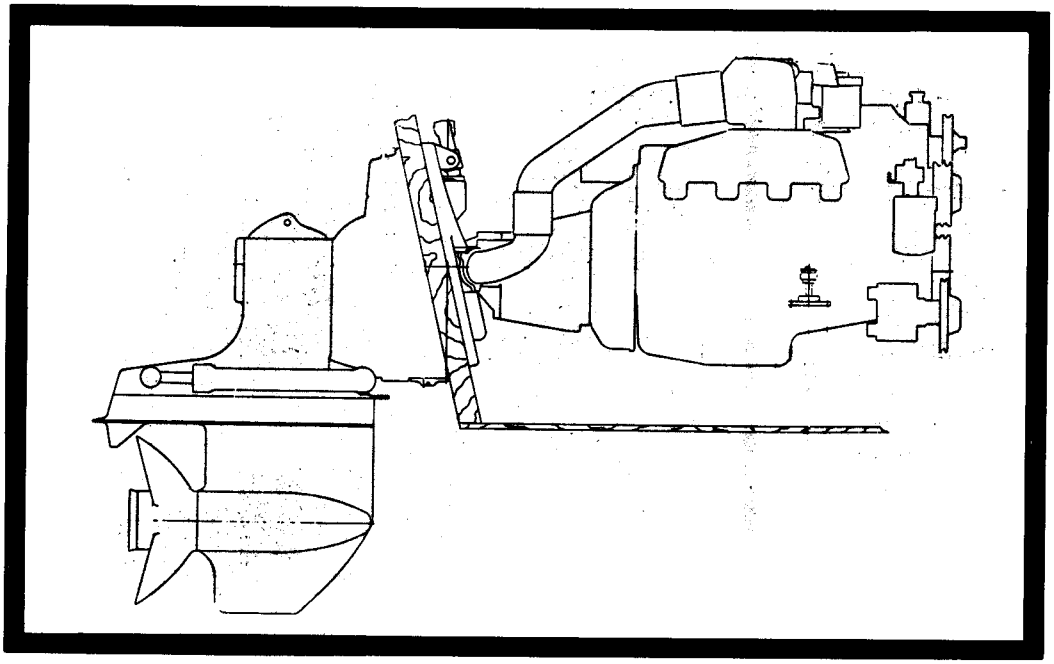


a - Cable End Guide
b - Throttle Lever Stud
c - Elastic Stop Nut and Flat Washer
d - Throttle Lever
e - Idle Speed Adjustment Screw (Must Contact Idle Speed Stop Screw)
f - Brass Barrel
g - Throttle Cable Anchor Stud

REMOVAL and INSTALLATION

2

C



330 (B-W) TR-TRS

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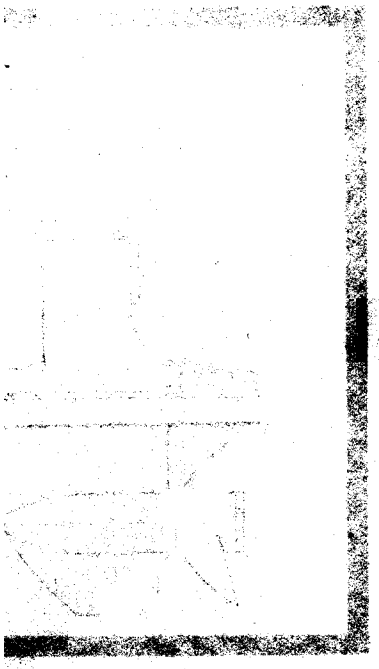
Attaching/Adjusting Shift Cable	2C-5
Attaching/Adjusting Throttle Cable	2C-6



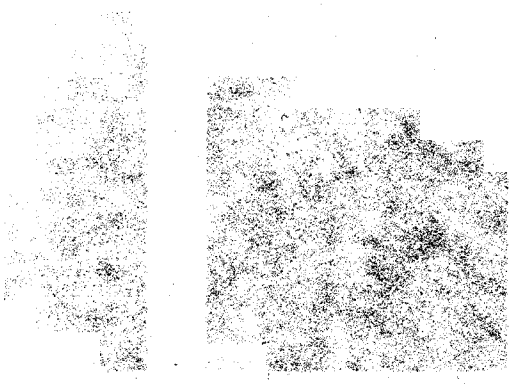
TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Front Engine Mount	Securely	
Hose Clamps	Securely	
Power Steering Fluid Hose Fittings Large Small	20-25 (27-34)	 96-108 (11-12)
Rear Engine Mount	100 (136)	
Remote Control Shift Cable Brass Barrel Cable End Guide	 (Note 1) (Note 1)	
Remote Control Throttle Cable Brass Barrel Cable End Guide	 (Note 1) (Note 1)	

NOTE 1: Tighten, then back nut off 1/2 turn.

TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Marine-Lube



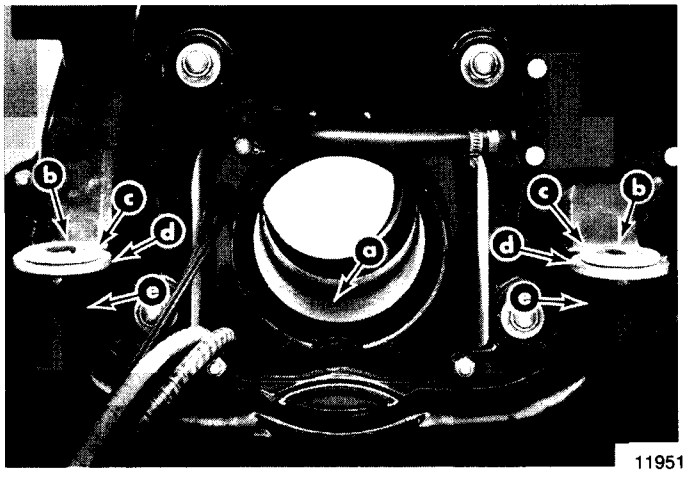
Removal

IMPORTANT: Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual".

1. Disconnect battery cables from battery and remove instrument harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Disconnect trim position sender wires from terminal block on flywheel housing.
4. Disconnect water inlet hose and exhaust elbow bellows.
5. Remove shift cable.
6. Remove buzzer tan/blue wire from water heat switch in thermostat housing.
7. Disconnect any grounding wire or accessories that are connected to the engine.
8. **Power Steering Models:** Disconnect fluid hoses from power steering control valve.
9. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.
10. Pull engine forward to disengage transmission output housing from gimbal housing and carefully remove engine.

Installation/Allignment

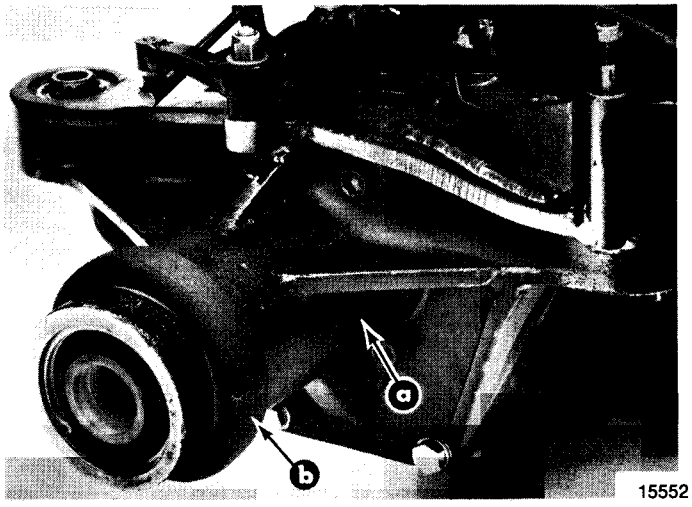
1. Prepare transom assembly as shown.



11951

a - Transom Gimbal Housing Assembly Opening (Lubricate with 2-4-C Marine Lube)
b - Double-Wound Lockwasher (2)
c - Fiber Washer (2)
d - Large Steel Washer (2)
e - Engine Supports

2. Prepare transomission output housing as shown.



15552

a - Transmission Output Housing
b - "O" Ring Seal (Lubricate with 2-4-C Marine Lube)

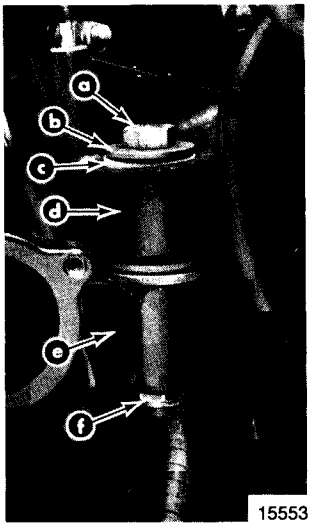
3. Lift engine with an overhead hoist, using a suitable sling and lifting eyes on engine.
4. Position engine ahead of inner transom plate so that transmission output housing is in line with large opening in inner transom plate.

IMPORTANT: Take care when installing engine in next step to prevent damage to "O" ring seal on transmission output housing.

5. Carefully guide transmission output housing into transom gimbal housing assembly until holes in rear engine mounts align with holes in inner transom plate engine supports.

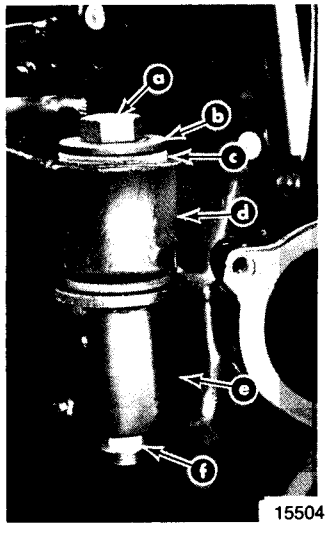
IMPORTANT: Do not relieve hoist tension entirely, as inner transom plate engine supports and/or transmission output housing may be damaged.

6. Relieve hoist tension, as required, to allow rear engine mounts to rest on inner transom plate engine supports and washers.
7. Secure rear engine mounts as shown. Torque bolts to specifications.



15553

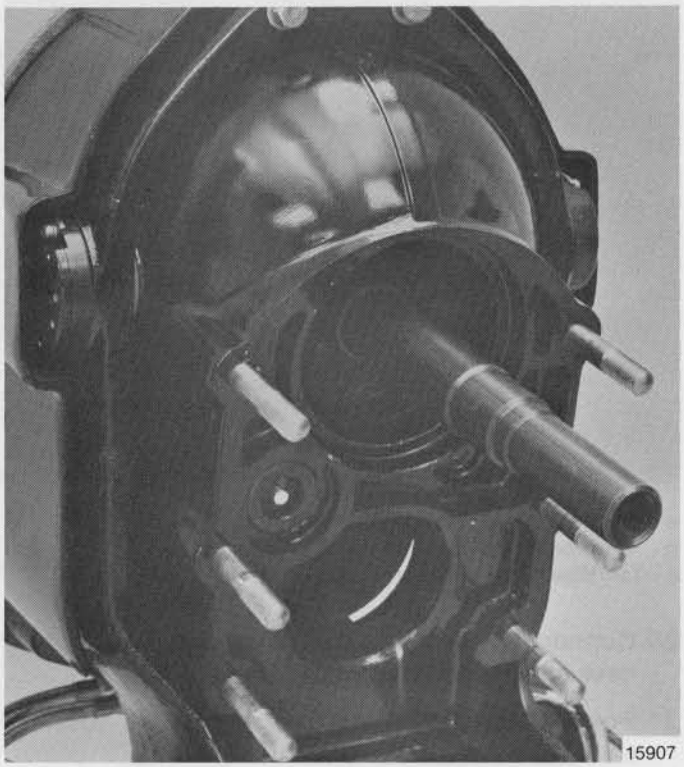
a - Bolt
b - Steel Washer
c - Fiber Washer
d - Rear Engine Mount



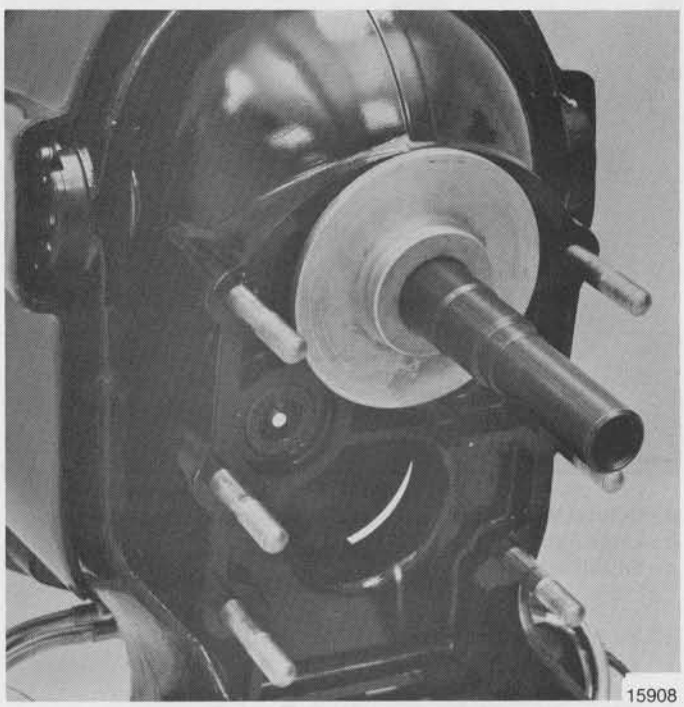
15504

e - Inner Transom Plate
f - Elastic Stop Nut

8. Insert solid end of Alignment Tool thru bell housing bore and into transmission output housing until it bottoms.


15907

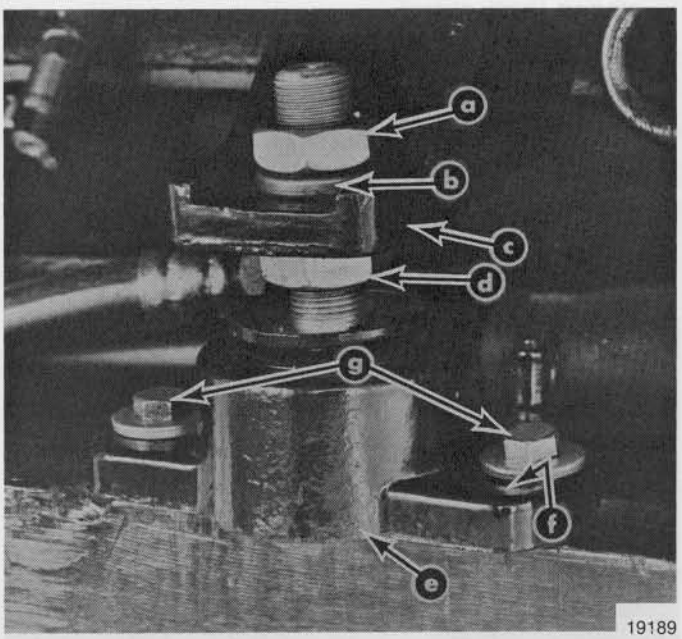
9. Slide plate toward bell housing and position bell housing, as required, to allow shoulder on plate to enter bell housing bore.


15908

10. With alignment tool plate positioned in bell housing and engine supported with hoist, front engine mounts should rest on top of stringers without disturbing alignment tool plate position when hoist tension is relieved.

NOTE: Boat stringers must position engine so that a minimum of 1/4" (6mm) of up-and-down front mount adjustment exists after mounts are lowered onto stringers.

11. Relieve hoist tension entirely and fasten front engine mounts (with slotted mounting hole toward front of engine) to stringers.



19189

a - Mounting Bolts

12. While pushing in on alignment shaft and plate, check for gap between plate and bell housing rear surface at 12, 6, 3 and 9 o'clock positions. Engine alignment is correct when no gap exists at any position. If a gap exists, proceed as follows.

GAP AT 12 O'CLOCK POSITION

Loosen locking nuts on front engine mounts. Both mounts must be adjusted equally to keep engine level from side to side. Turn adjusting nut on both mounts equally counterclockwise to raise front of engine, until no gap exists. Tighten locking nuts securely (until lockwasher is compressed).

GAP AT 6 O'CLOCK POSITION

Loosen locking nuts on front engine mounts. Both mounts must be adjusted equally to keep engine level from side to side. Turn adjusting nut on both mounts equally clockwise to lower front of engine, until no gap exists. Tighten locking nuts securely (until lockwasher is compressed).

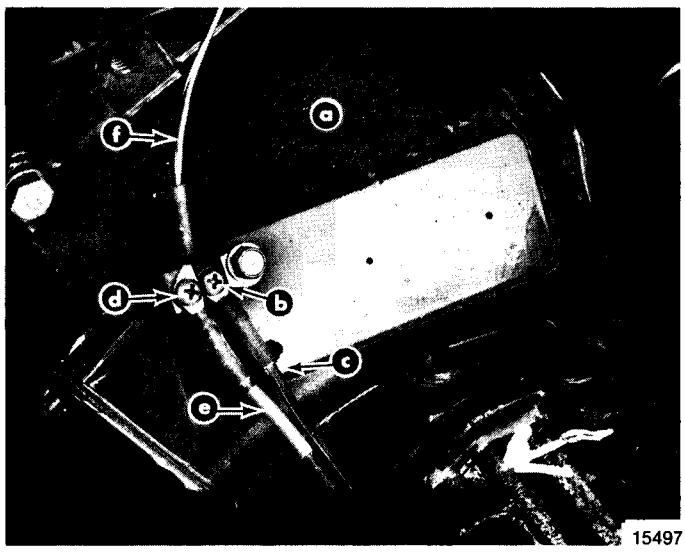
GAP AT 3 O'CLOCK POSITION

Loosen lag bolts which fasten front engine mounts to boat stringers and move engine to the right (starboard) until no gap exists. Retighten lag bolts securely.

GAP AT 9 O'CLOCK POSITION

Loosen lag bolts which fasten front engine mounts to boat stringers and move engine to the left (port) until no gap exists. Retighten lag bolts securely.

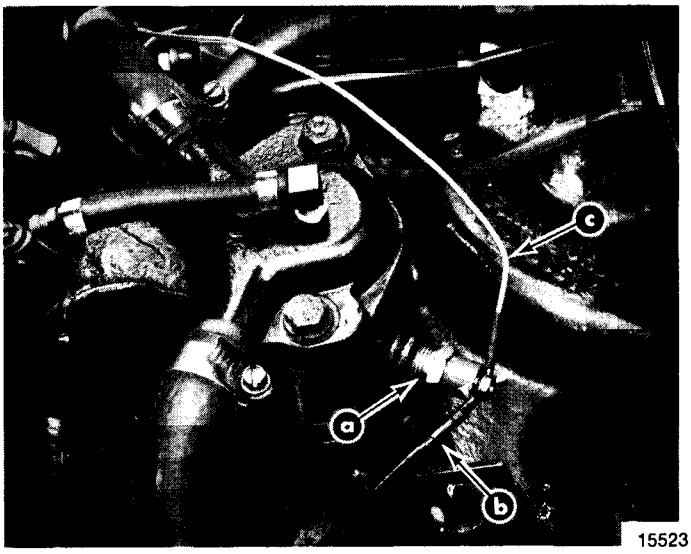
12. After correct alignment has been attained, re-check all mount fasteners to be sure that they are tight.
13. Remove alignment shaft and plate.
14. Retighten bellows clamps on exhaust manifold elbows (both sides).
15. Connect water inlet hose to seawater pump. Tighten clamp securely.
16. Connect instrument harness to engine harness. Secure with clamp and tighten securely.
17. Connect fuel line. Check for leaks.
18. Connect trim position sender wires as shown.



15497

a - Flywheel Housing
b - Terminal Block Mounting Screw
c - Wire without Purple or Brown Sleeve
d - Insulated Terminal
e - Wire with Purple or Brown Sleeve
f - Brown/White Wire

19. Connect tan/blue buzzer wire as shown.

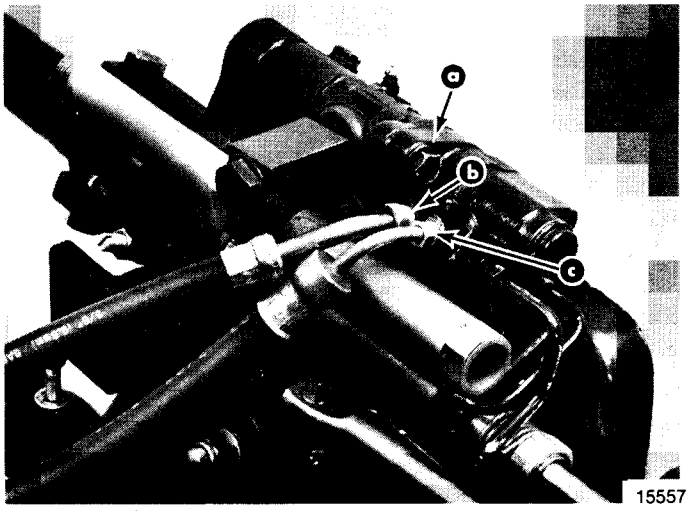


15523

a - Cooling System Water Heat Switch
b - Tan/Blue Wire (From Oil Pressure Switch)
c - Tan/Blue Wire From Buzzer

20. Connect any ground wires or accessories that may have been disconnected.
21. **Power Steering Models:** Reconnect fluid hoses as shown.

IMPORTANT: Bleed power steering system as outlined in "Stern Drive Service Manual".



15557

a - Control Valve
b - Large Fitting
c - Small Fitting
— Torque to Specifications

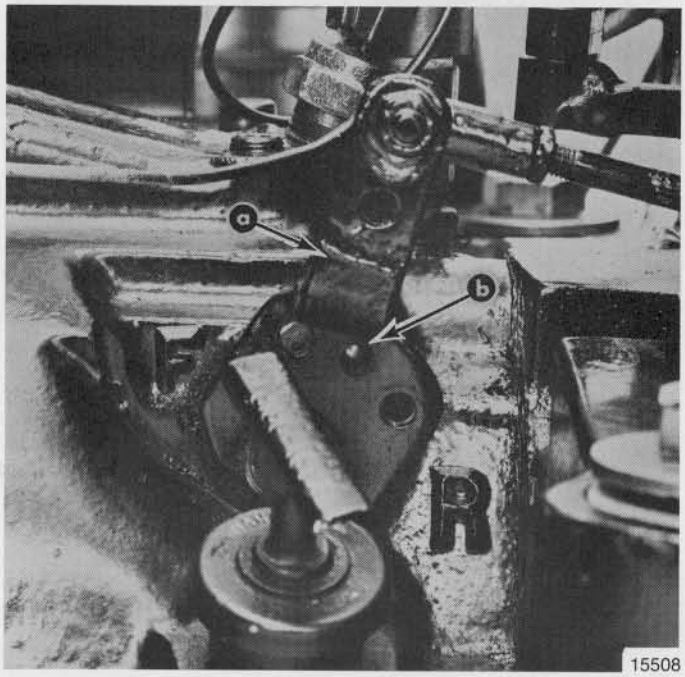
22. For shift and throttle connections, refer to the following:

    "Attaching/Adjusting Shift Cable"
    "Attaching/Adjusting Throttle Cable"

23. Connect battery cable to battery.

Attaching/Adjusting Shift Cable

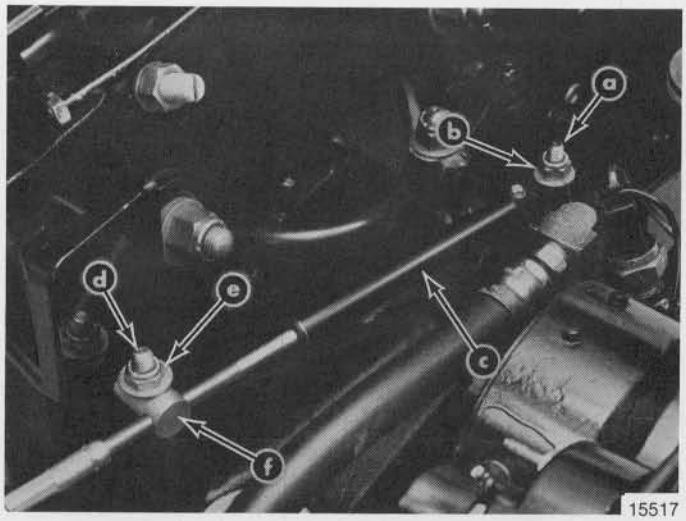
1. Place remote control shift lever in neutral position.
2. Place transmission shift lever in neutral position, indicated when poppet ball (located behind shift lever) is in center detent hole of shift lever.



15508

a - Shift Lever
b - Poppet Ball In Center Hole of Shift Lever

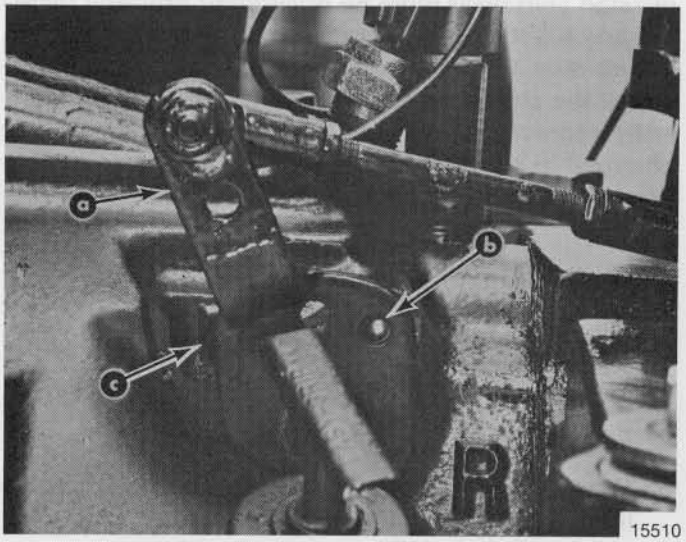
3. Adjust brass barrel on shift cable, as required, to align shift cable attaching holes with shift cable lever and shift cable anchor studs. Center the cable end play travel when making adjustment.
4. Install shift cable and secure with flat washers and elastic stop nuts. Tighten nuts to specifications.



15517

a - Lever Stud
b - Washer and Nut
c - Cable End Guide
d - Anchor Stud
e - Washer and Nut
f - Brass Barrel

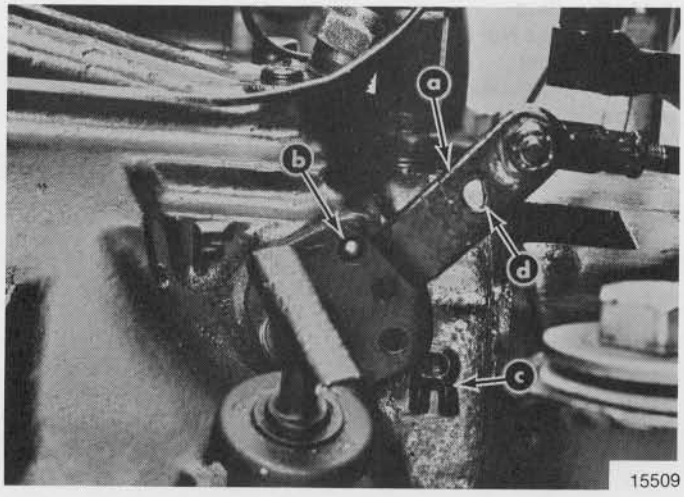
5. Place remote control shift lever in full forward gear position. Check position of transomission shift lever. Transmission shift lever must be positioned so that the poppet ball is in rear detent hole of shift lever.



15510

a - Shift Lever
b - Poppet Ball In Rear Detent Hole
c - "F" On Transmission Case

6. Place remote control lever in full reverse gear position and, again, check transmission shift lever position. Poppet ball must be in front detent hole of shift lever.
7. If transmission shift lever is positioned correctly in one gear (forward or reverse), but not in the other, recheck shift cable adjustment. If transmission shift lever is not positioned properly in both gears, move shift rod stud from top hole in transmission lever to bottom hole and recheck for proper positioning of shift lever. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



15509

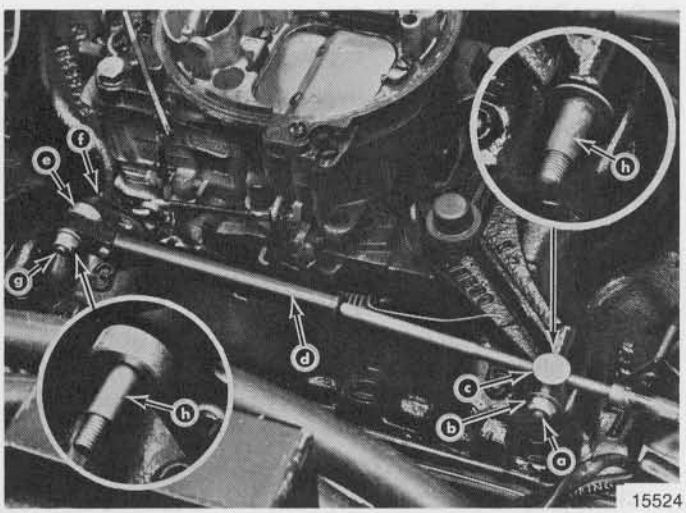
a - Shift Lever
b - Poppet Ball In Front Detent Hole
c - "R" On Transmission Case
d - Install Shift Rod Stud in This Hole, If Necessary, To Properly Position Shift Lever With Poppet Ball

⚠CAUTION

Remote control and shift cable must position transmission shift lever so that it is fully in the forward and reverse gear detent position and over the letter "F" on transmission case when propelling boat forward. Transmission shift lever must be positioned properly (without any modification to transmission) or transmission failure may occur. Warner Gear Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed; if the shift lever is repositioned or changed in any manner; or remote control and cable do not position shift lever correctly.

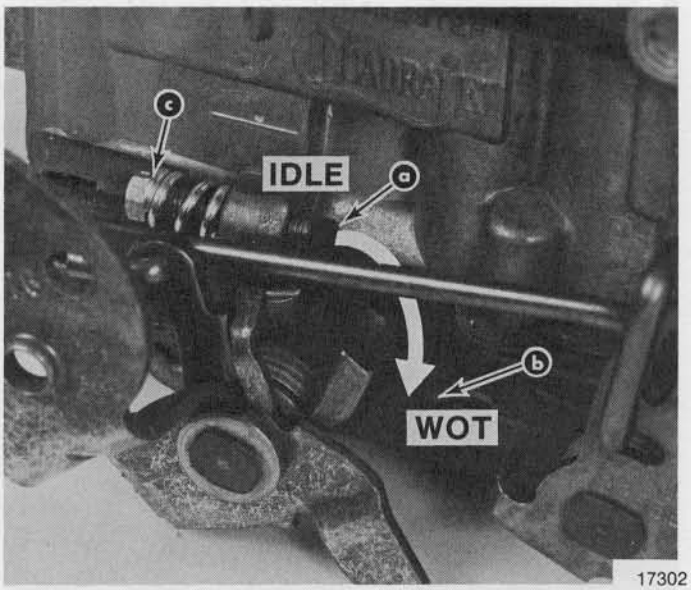
Attaching/Adjusting Throttle Cable

1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel as shown.



a - Anchor Stud
b - Washer and Nut (DO NOT Over-Tighten)
c - Brass Barrel
d - Cable End Guide
e - Spacer
f - Screw
g - Washer and Nut (DO NOT Over-Tighten)
h - Bushing

4. Check that throttle valve are fully open when remote control is in full throttle position.
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop.

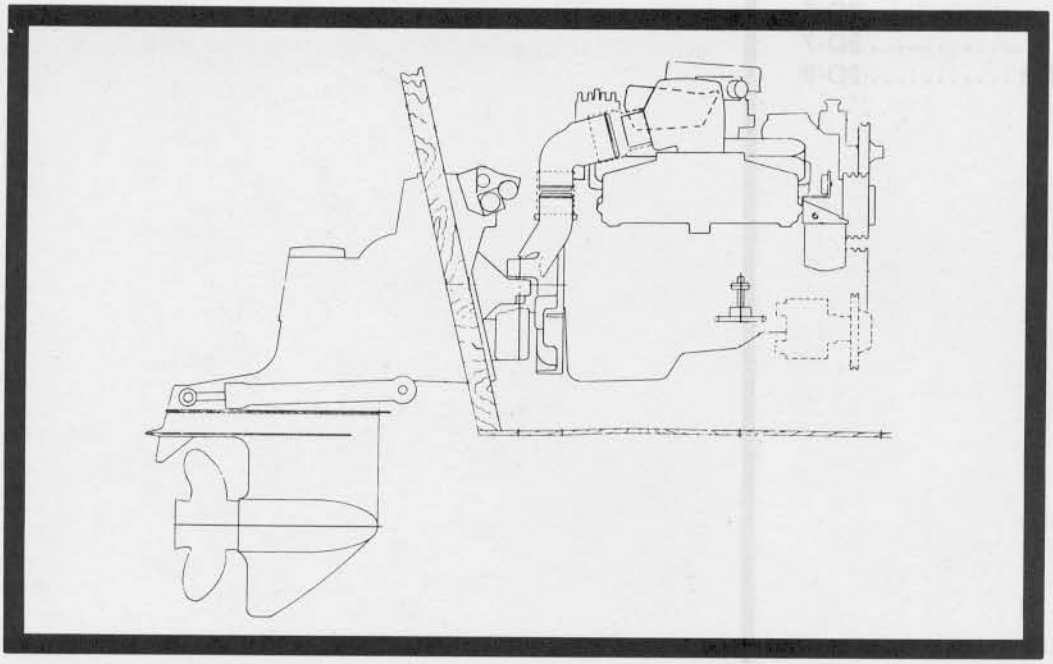


a - Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

REMOVAL and INSTALLATION

2

D



MCM MODELS with TRS DRIVE

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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Driveshaft to Tailstock Flange	50 (68) (Note 2)	
Driveshaft to Transmission Output Flange	35 (48)	
Drive Unit Shift Cable		
Brass Barrel	Spread Cotter Pin	
Cable End Guide	(Note 1)	
Front Engine Mount	Securely	
Front Engine Plate Mount	Securely	
Hose Clamps	Securely	
Power Steering Fluid Hose Fittings		
Large	20-25 (27-34)	
Small		96-108 (11-12)
Rear Engine Mounts (Transom Mounted Engine)	100 (136)	
Rear Engine Plate Mount	Securely	
Rear Engine Mounts	35-40 (47-54)	
Remote Control Shift Cable		
Brass Barrel	Securely	
Cable End Guide	(Note 1)	
Remote Control Throttle Cable		
Brass Barrel	Securely	
Cable End Guide	(Note 1)	
Remote Control Shift Cable		
Brass Barrel	(Note 1)	
Cable End Guide	(Note 1)	
Remote Control Throttle Cable		
Brass Barrel	(Note 1)	
Cable End Guide	(Note 1)	
Tailstock Housing Compression Nuts		70 (8)
Tailstock Mounts	100 (136)	

NOTES: 1. Tight, then back nut off 1/2 turn.

2. Secure with safety wire.

TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Marine Lube

Removal

IMPORTANT: Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual."

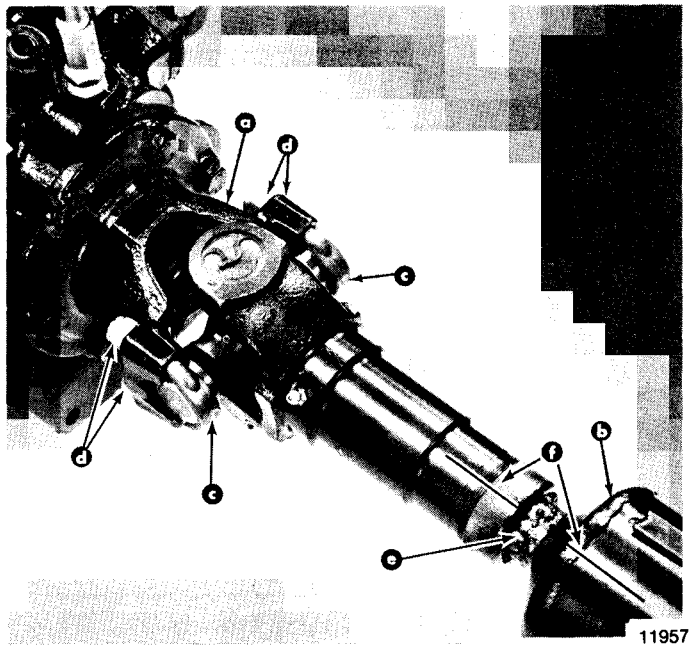
1. Disconnect battery cables from battery and remove instrument harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Disconnect trim position sender wire (some models).
4. Remove red and black Power Trim pump motor wires from engine (some models).
5. Disconnect water inlet hose and exhaust system.
6. Remove shift cable.
7. Disconnect any grounding wire or accessories that are connected to the engine.
8. **Power Steering Models:**
   a. Fluid Cooler Mounted on Engine: Disconnect fluid hoses from power steering control valve.
   b. Fluid Cooler mounted on Stringer: Disconnect fluid hoses from cooler.
9. **Models with Transmission Oil Cooler Mounted on Stringer:** Disconnect oil hoses from cooler. Mark location each hose was removed from.
10. **Models with Engine Oil Cooler Mounted on Stringer:** Disconnect oil hoses from cooler. Mark location each hose was removed from.
11. Disconnect hydraulic hoses from reverse lock valve located on transmission (some models).
12. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.
13. **Transom Mounted Engine:** Pull engine forward to disengage transmission output housing from gimbal housing and carefully remove engine.

IMPORTANT: Driveshaft has been assembled and balanced at the factory with the universal joint yoke on both ends of shaft running in the same plane. If it is necessary to remove splined end of shaft, end must be reinstalled in splines in exactly the same position as factory assembled, or damage to universal joints and driveshaft may result.

14. **Engine with Driveshaft:**

    Method A: Mark driveshaft in two locations as shown, pull engine forward to disengage driveshaft splines and carefully remove engine.

    Method B: Disconnect driveshaft from transmission output shaft. Carefully remove engine.



11957

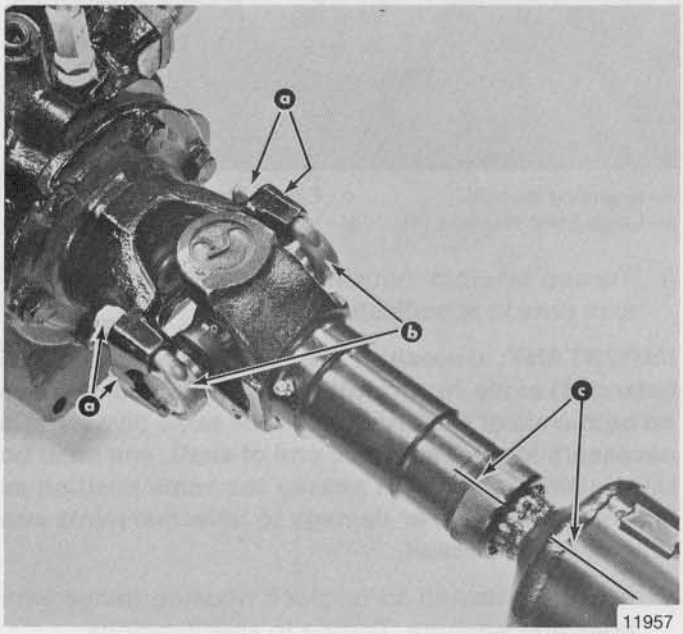
a - Transmission Output Shaft
b - Driveshaft
c - U-Bolts (2)
d - Elastic Stop Nuts (4)
e - Splines
f - Make Alignment Marks With Paint

Removal of Tailstock Housing (Driveshaft Models)

⚠CAUTION

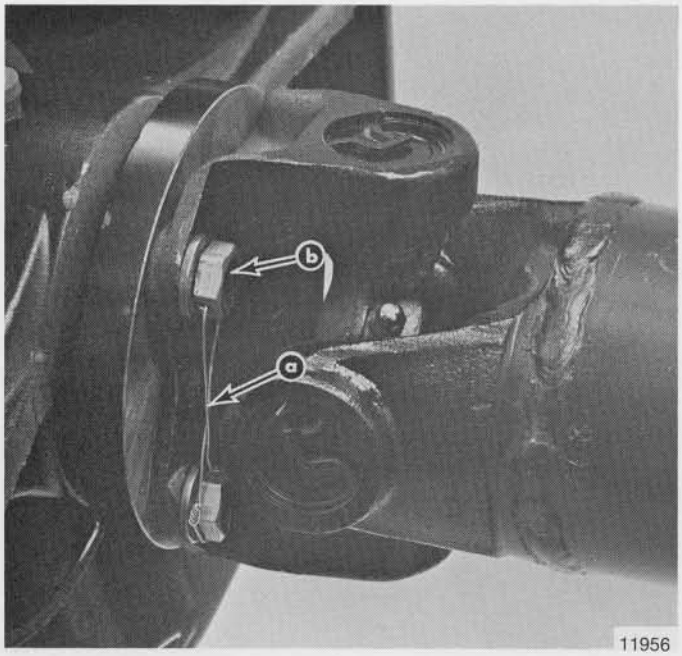
Driveshaft has been assembled and balanced at the factory with the universal joint yokes on both end of shaft running in the same plane. If it is necessary to remove splined end of shaft, mark driveshaft in two locations as shown. Driveshaft splines must be aligned in exactly the same position as factory assembled, or damage to universal joints and driveshaft may occur.

1. Disconnect both ends of driveshaft as shown.



11957

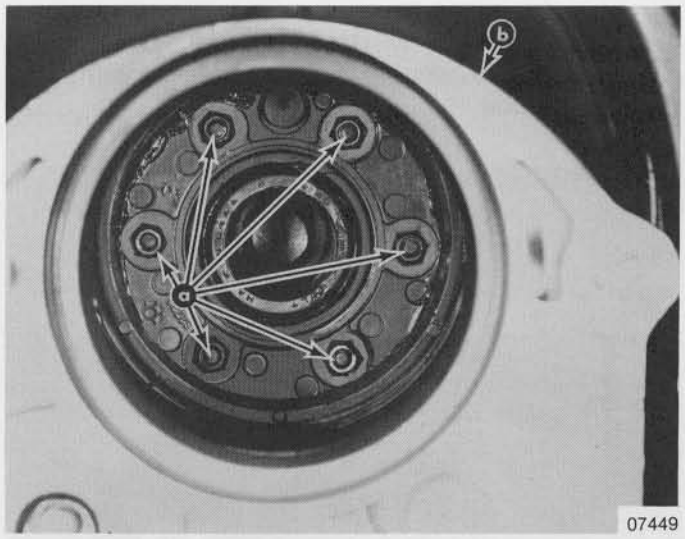
a - Remove 4 Nuts
b - Remove 2 U-Bolts
c - Make Alginment Marks With Paint



11956

a - Cut Safety Wire
b - Remove 4 Bolts and Washers

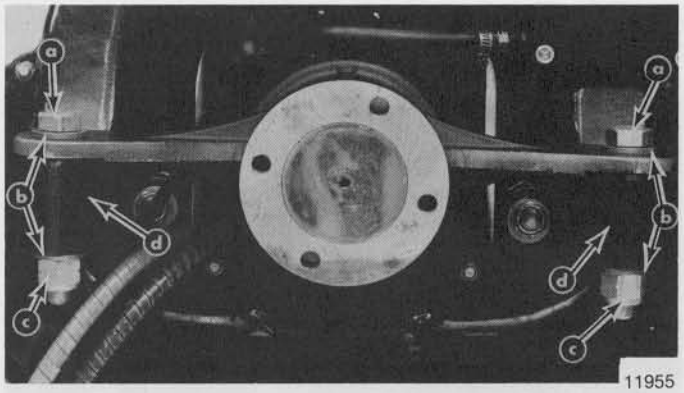
2. Remove driveshaft.
3. Loosen tailstock compression nuts.



07449

a - Compression Nuts
b - Bell Housing

4. Remove tailstock housing to inner transom plate support fasteners.



11955

a - Mounting Bolt (2)
b - Large Steel Washers (4)
c - Elastic Stop Nut (2)
d - Inner Transom Plate Support (2)

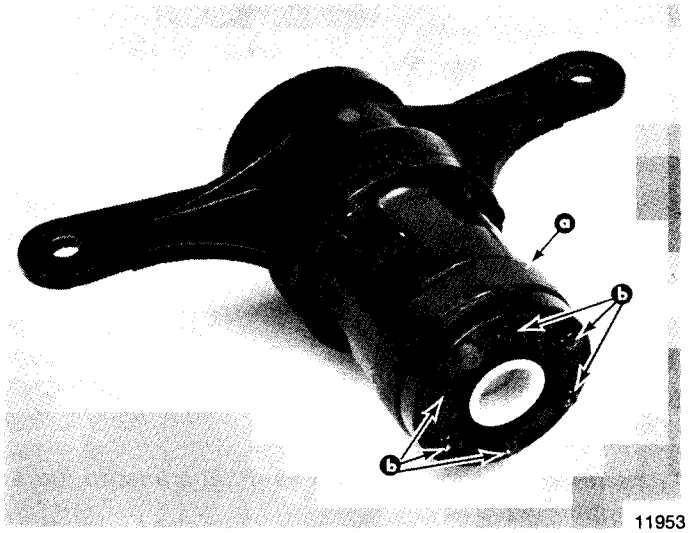
5. Remove tailstock housing from opening in gimbal housing.

11953

Installation

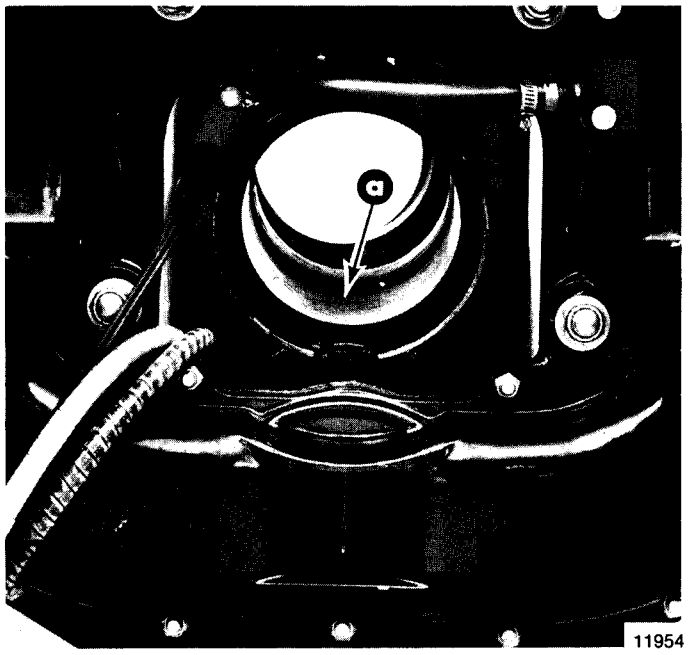
Driveshaft Models

1. Lubricate rubber "O" ring seal on tailstock housing assembly and opening in gimbal housing with 2-4-C Marine Lube.



11953

a - "O" Ring Seal (Lubricate with 2-4-C Marine Lube)
b - Compression Nuts (6)

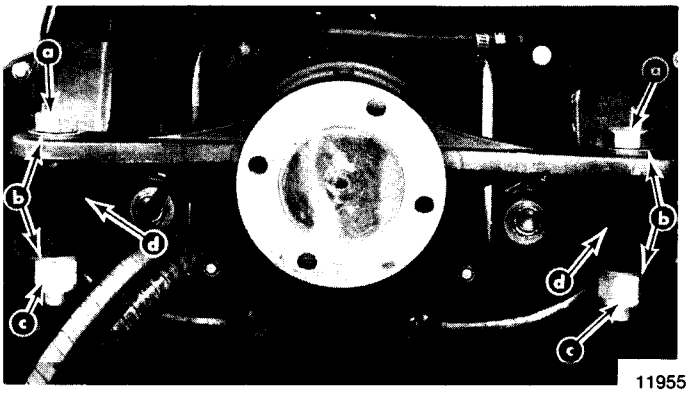


11954

a - Gimbal Housing Opening (Lubricate with 2-4-C Marine Lube)

2. Loosen tailstock housing compression nuts.

3. Insert tailstock housing assembly into gimbal housing opening until holes in housing align with holes in inner transom plate supports. Secure tailstock housing to inner transom plate supports with bolts, flat washers and elastic stop nuts, as shown. Torque to specifications.



11955

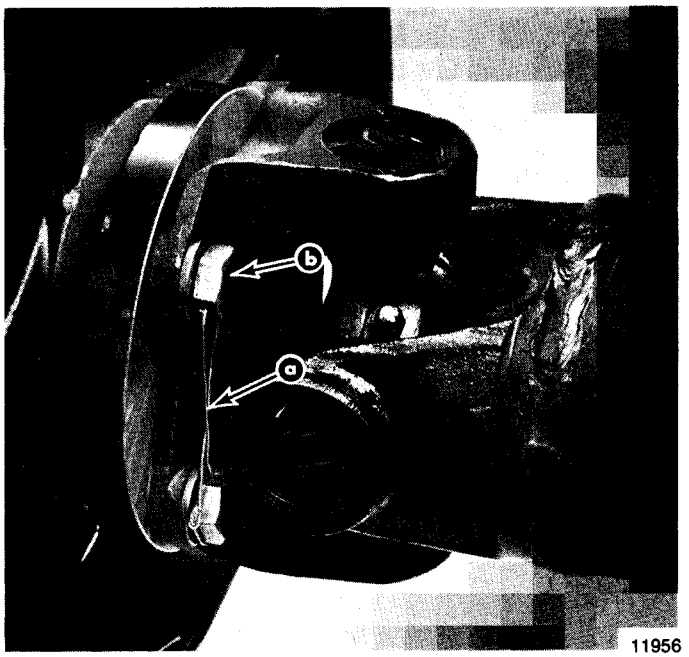
a - Mounting Bolt (2)
b - Large Steel Washers (4)
c - Elastic Stop Nut (2)
d - Inner Transom Plate Support (2)

4. Torque tailstock housing "O" ring seal compression nuts to specifications.

IMPORTANT: Driveshaft has been assembled (and balanced) at the factory with the universal joint yokes on both ends of shaft running in the same plane. If it is necessary to remove spline end of shaft, end must be reinstalled in splines in exactly the same position as factory assembled, or damage to universal joints and drive shaft may result.

5. Attach driveshaft to tailstock housing flange with bolts and washers. Torque to specifications.

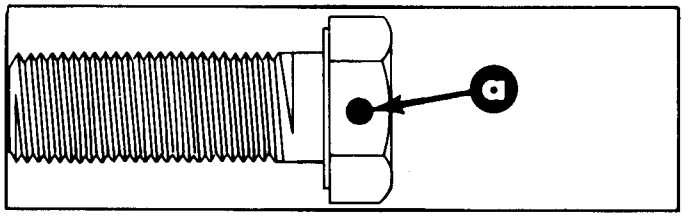
6. Secure bolts with stainless steel safety wire, in such a manner that it does not loosen bolts.



11956

a - Safety Wire
b - Bolts

IMPORTANT: For bolt heads without holes, drill as shown for safety wire.



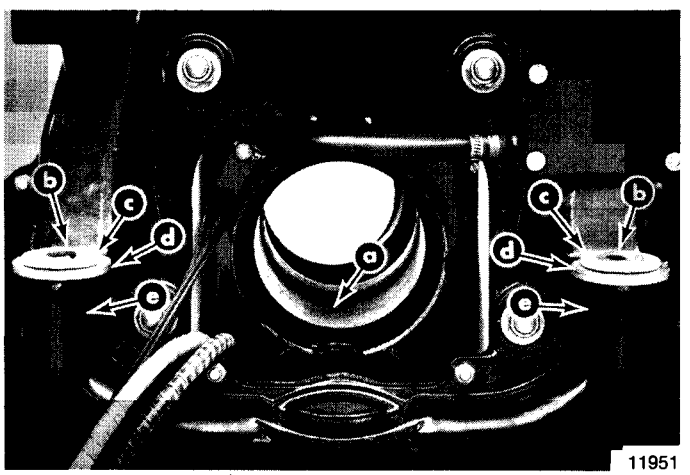
a - 1/16" (2mm) Dia. Hole Thru

7. Attach driveshaft to transmission output shaft with U-bolts and elastic stop nuts. Torque to specifications.
8. With dual engines mounted to boat stringers, port engine must sit 1" to 1-5/16" (25 to 33mm) above or below starboard engine and parallel to crankshaft centerline of starboard engine (both vertically and horizontally). Make sure that engine is directly in line with tailstock housing. Move engine back-or-forward, so that driveshaft splines are positioned at approximately mid travel. This will place driveshaft at a 1°-3° angle to crankshaft centerline necessary for proper drive shaft operation.
9. Fasten front and rear mounts using fasteners that had been removed. Tighten bolts and nuts securely.

Installation

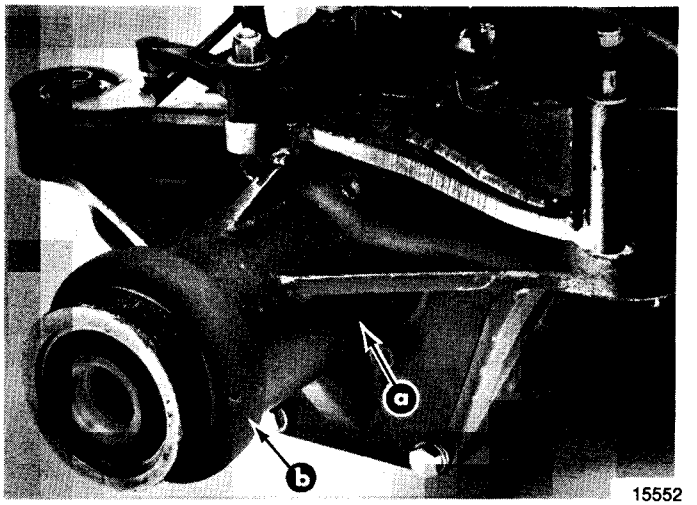
Transom Mounted Model

1. Prepare transom assembly as shown.



a - Gimbal Housing Opening (Lubricate with 2-4-C Marine Lube)
b - Double-Wound Lockwasher (2)
c - Fiber Washer (2)
d - Large Steel Washer (2)
e - Engine Supports

2. Prepare transmission output housing as shown.



a - Transmission Output Housing
b - "O" Ring Seal (Lubricate with 2-4-C Multi-Lube)

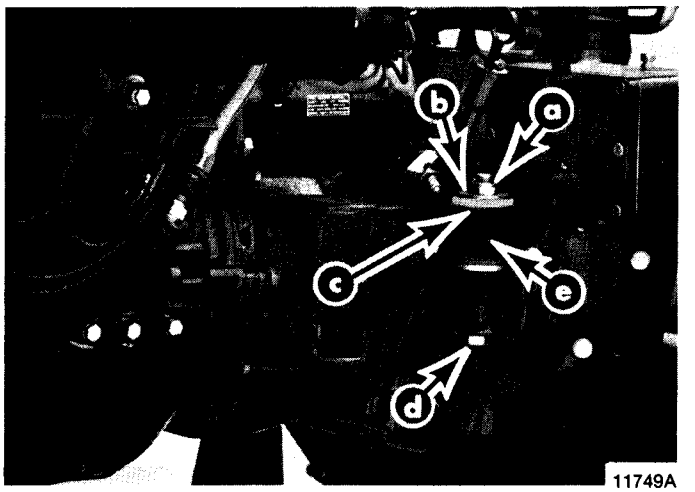
3. Lift engine with an overhead hoist, using a suitable sling and lifting eyes on engine.
4. Position engine so that transmission output housing is in line with large opening in inner transom plate.

IMPORTANT: Take care when installing engine in next step to prevent damage to "O" ring seal on transmission output housing.

5. Carefuly guide transmission output housing into transom gimbal housing assembly until holes in rear engine mounts align with holes in inner transom plate engine supports.

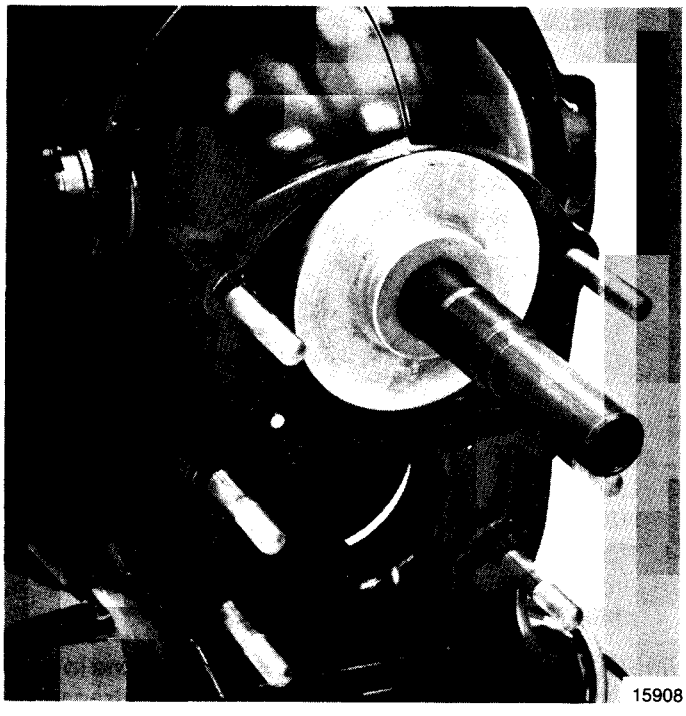
IMPORTANT: Do not relieve hoist tension entirely, as inner transom plate engine supports and/or transmission output housing may be damaged.

6. Relieve hoist tension, to allow rear engine mounts to rest on inner transom plate engine supports and washers.
7. Insert mounting bolts up thru inner and rear mounts as shown. Torque to specifications.



a - Elastic Stop Nut
b - Steel Washer
c - Fiber Washer
d - Bolt
e - Rear Engine Mount

8. Insert solid end of Alignment Tool thru bell housing bore and into transmission output housing until it bottoms. Slide plate toward bell housing and position bell housing to allow shoulder on plate to enter bell housing bore.


15908

9. While pushing in on alignment shaft and plate, check for gap between plate and bell housing rear surface at 12, 3, 6 and 9 o'clock positions. Engine alignment is correct when no gap exists at any position. If a gap exists, proceed as follows:

   Gap at 12 o'clock Position

   Raise front of engine with hoist, as required, until gap no longer exists.

   Gap at 6 o'clock Position

   Lower front of engine with hoist, as required, until gap no longer exists.

   Gap at 3 o'clock Position

   Move engine to the right (starboard) until gap no longer exists.

   Gap at 9 o'clock Position

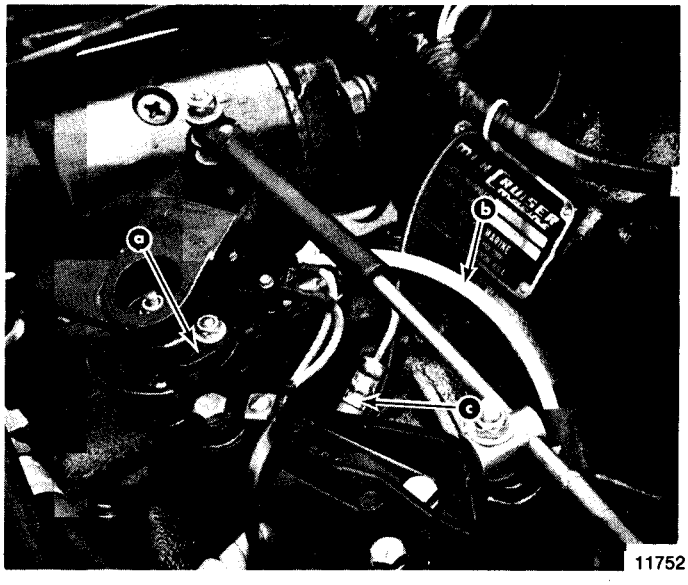
   Move engine to the left (port) until gap no longer exists.

10. After correct alignment has been attained, fasten front mounts. Tighten fasteners securely.
11. After engine has been fastened securely to boat, recheck engine alignement to ensure that engine has not moved; then remove alignment tool.
12. Refer to "Completing Installation".

Completing Installation

1. Connect hydraulic hoses to reverse lock valve as shown. (Some models).
2. **Models with Engine Oil Cooler Mounted on Stringer:** Connect oil hoses to the same fittings that they were removed from.
3. **Models with Transmission Oil Cooler Mounted on Stringer:** Connect oil hoses to the same fittings that they were removed from.

Reverse Lock Valve (Some Models)



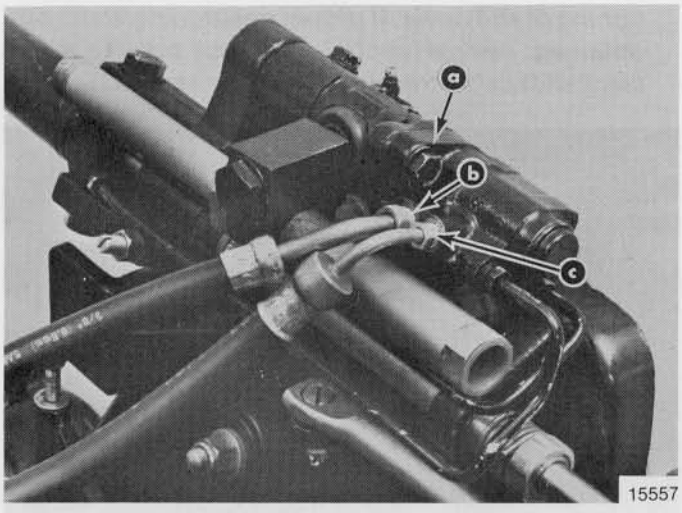
11752

a - Reverse Lock Valve
b - Plastic Hose (From Power Trim Pump)
c - Gray Hose (From Transom Assembly)

IMPORTANT: Check all oil levels before and after first 5 minutes of running time.

4. **Power Steering Models:**
   a. Fluid Cooler Mounted on Engine: Reconnect fluid hoses to power steering control valve as shown.
   b. Fluid Cooler Mounted on Stringer: Reconnect fluid hoses to cooler.

IMPORTANT: Bleed power steering system as outlined in "Stern Drive Service Mnaual".

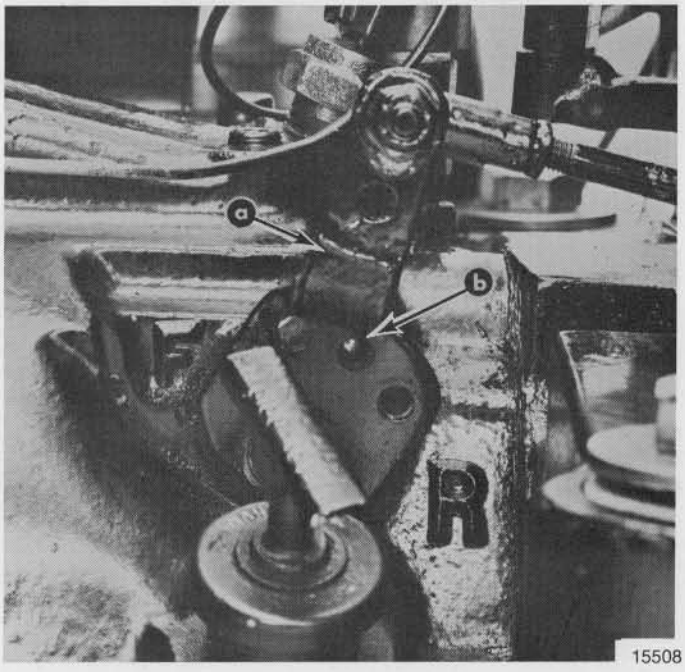


a - Control Valve
b - Large Fitting
c - Small Fitting
— Torque to Specifications

5. Reconnect any grounding wire or accessories that were removed.
6. Connect shift cable. Refer to "Attaching/Adjusting Shift Cable".
7. Reconnect trim position sender wire (some models).
8. Reconnect seawater inlet hose and exhaust system. Tighten clamps securely.
9. Reconnect red and black Power Trim pump motor wires to engine (some models).
10. Reconnect fuel line. Check for fuel leaks.
11. Connect throttle cable. Refer to "Attaching/Adjusting Throttle Cable".
12. Connect instrument harness to engine harness. Secure with clamp and tighten securely.
13. Connect battery cables to battery.

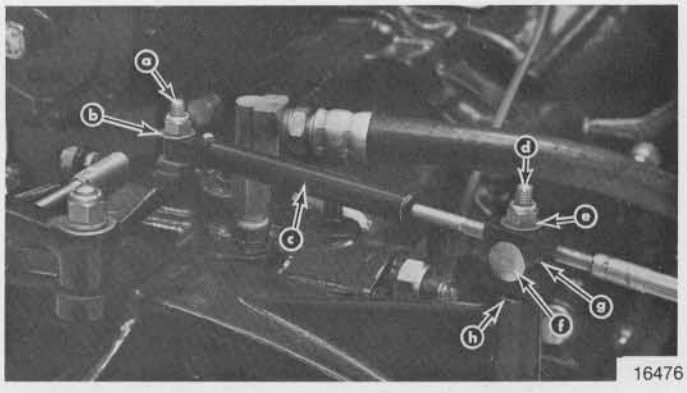
Attaching/Adjusting Shift Cable

1. Place remote control shift lever in neutral position.
2. Place transmission shift lever in neutral position, indicated when poppet ball (located behind shift lever) is in center detent hole of shift lever.



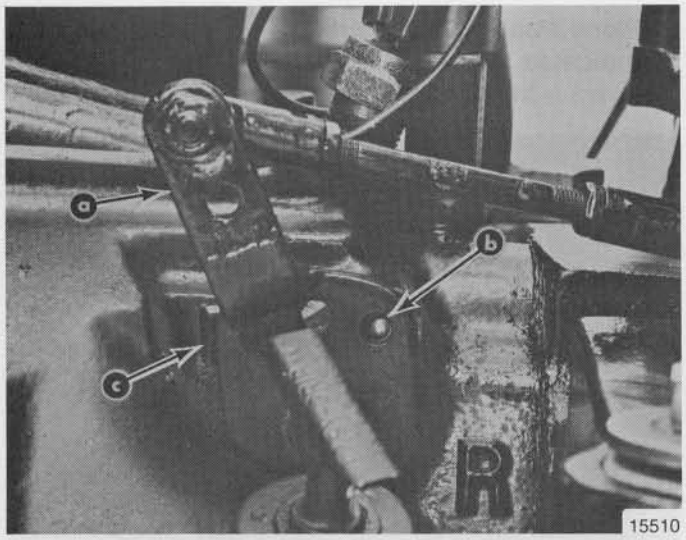
a - Shift Lever
b - Poppet Ball In Center Hole of Shift Lever

3. Adjust brass barrel on shift cable, as required, to align shift cable attaching holes with shift cable lever and shift cable anchor studs. Center the cable end play travel when making adjustment.
4. Install shift cable and secure with flat washers and elastic stop nuts. Tighten nuts to specifications.



a - Lever Stud
b - Washer and Nut
c - Cable End Guide
d - Anchor Stud
e - Washer and Nut
f - Brass Barrel
g - Shift Cable Barrel Clamp Block
h - Washer

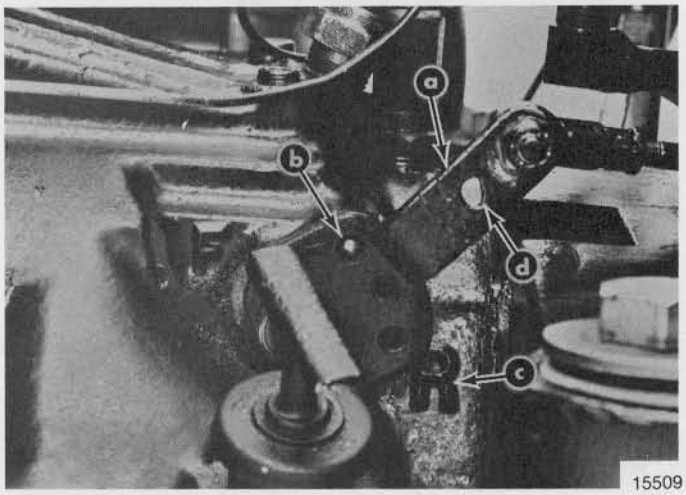
5. Place remote control shift lever in full forward gear position. Transmission shift lever must be positioned so that the poppet ball is in rear detent hole of shift lever.



a - Shift Lever
b - Poppet Ball In Rear Detent Hole
c - "F" On Transmission Case

6. Place remote control lever in full reverse gear position and, again, check transmission shift lever position. Poppet ball must be in front detent hole of shift lever.

7. If transmission shift lever is positioned correctly in one gear (forward or reverse), but not in the other, recheck shift cable adjustment. If transmission shift lever is not positioned properly in both gears, move shift rod stud from top hole in transmission shift lever to bottom hole and recheck for proper positioning of shift lever. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



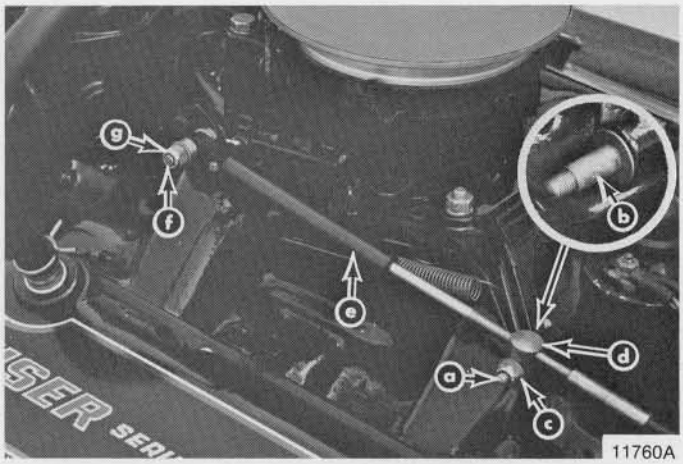
a - Shift Lever
b - Poppet Ball In Front Detent Hole
c - "R" On Transmission Case
d - Install Shift Rod Stud in This Hole, If Necessary, To Properly Position Shift Lever With Poppet Ball

⚠CAUTION

Remote control and shift cable must position transmission shift lever so that it is fully in the forward and reverse gear detent position and over the letter "F" on transmission case when propelling boat forward. Transmission shift lever must be positioned properly (without any modification to transmission) or transmission failure may occur. Warner Gear Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed; if the shift lever is repositioned or changed in any manner; or remote control and cable do not position shift lever correctly.

Attaching/Adjusting Throttle Cables

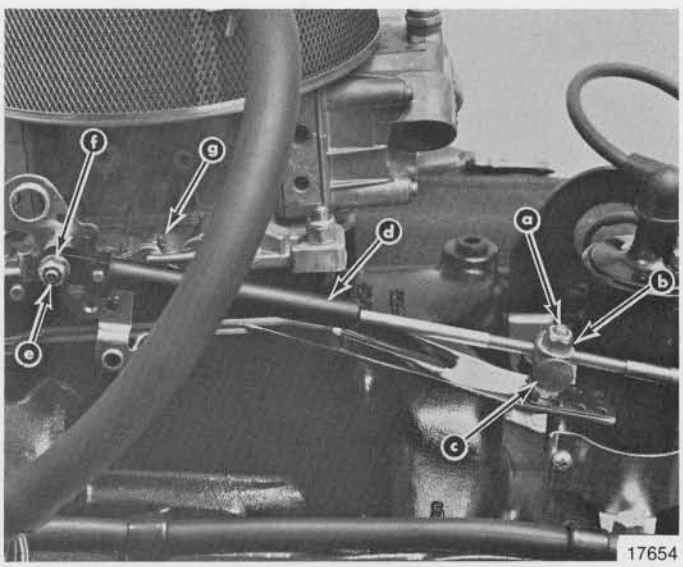
1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel as shown.



11760A

(Rochester Carburetor)

a - Anchor Stud
b - Bushing
c - Washer and Nut (Do Not Over-Tighten)
d - Brass Barrel
e - Cable End Guide
f - Lever Stud
g - Washer and Nut (Do Not Over-Tighten)

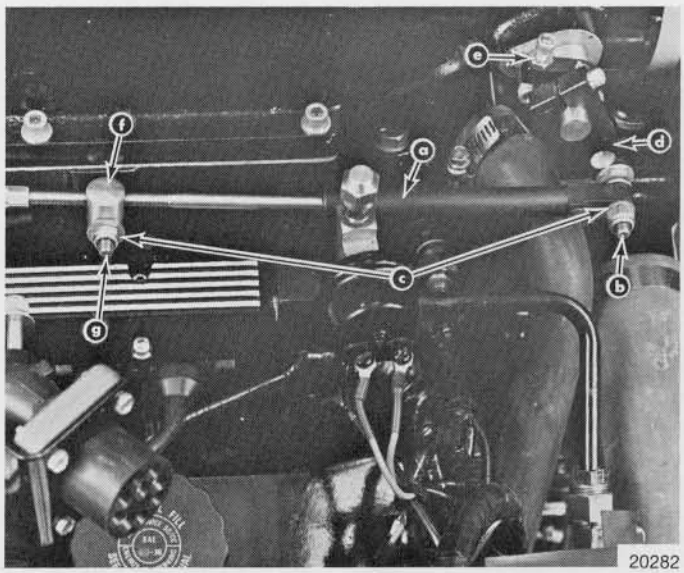


17654

(Holley Carburetor)

a - Anchor Stud
b - Washer and Nut (Do Not Over-Tighten)
c - Brass Barrel
d - Cable End Guide
e - Lever Stud
f - Washer and Nut (Do Not Over-Tighten)
g - Idle RPM Adjustment Screw

4. Check that throttle valves are fully open when remote control is in full throttle position.
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop.



20282

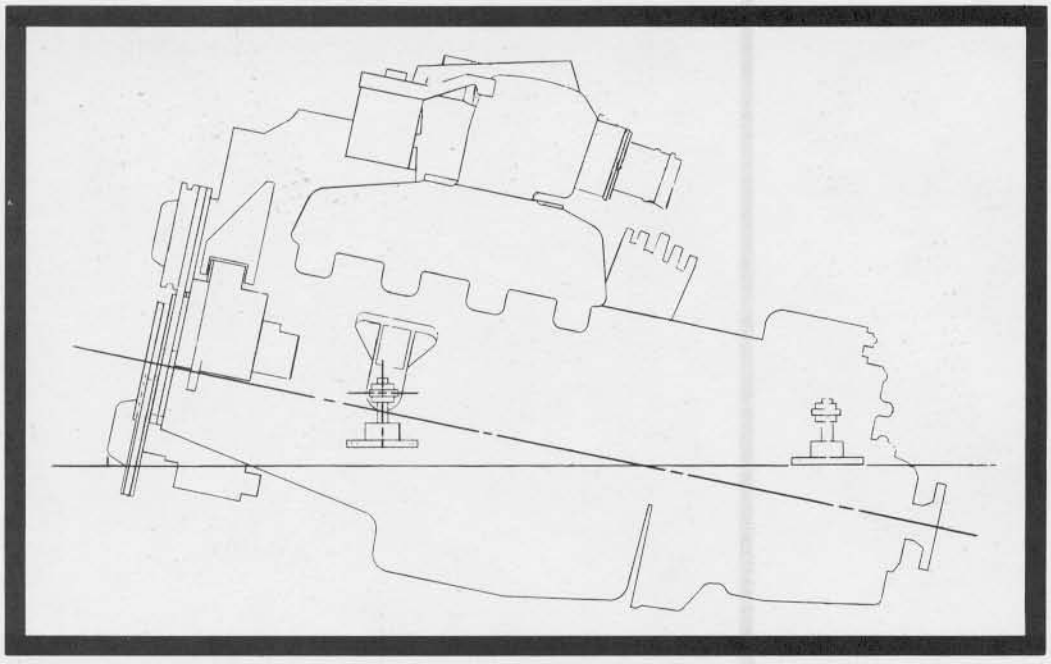
320 EFI

a - Cable End Guide
b - Throttle Lever Stud
c - Elastic Stop Nut and Flat Washer
d - Throttle Lever
e - Idle Speed Adjustment Screw (Must Contact Idle Speed Stop Screw)
f - Brass Barrel
g - Throttle Cable Anchor Stud

REMOVAL and INSTALLATION

2

E



MIE MODELS 230/260/340/5.7L SKI/5.0 LITRE/ 5.7 LITRE/7.4 LITRE

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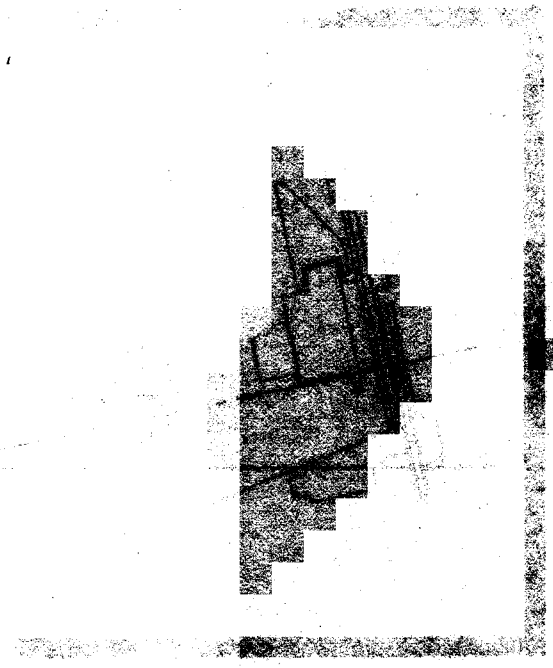


TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Battery Cables	Securely
Engine Mount Pads	Securely
Hose Clamps	Securely
Mount Locking Nut	Securely (Note 2)
Propeller Shaft Coupling	50 (68)
Remote Control Shift Cable Brass Barrel Cable End Guide	 Securely (Note 1)
Remote Control Throttle Cable Brass Barrel Cable End Guide	 Securely (Note 1)
Trunnion Clamping Screw/Nut	50 (68)

NOTES:

1. Tighten, then back nut off 1/2 turn.
2. Bend tab against adjusting nut.

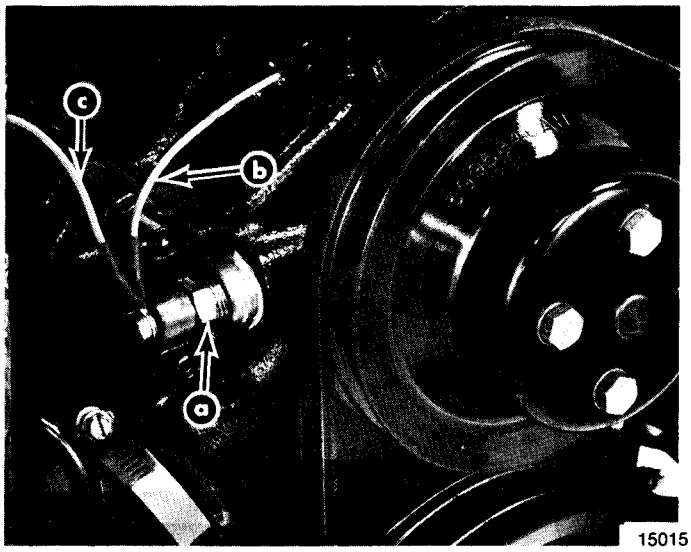
LUBRICANTS

LUBRICANTS	
92-86154A1	Quicksilver 2-4-C Marine-Lube

Removal

1. Disconnect battery cables from battery and remove instrument panel harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Disconnect shift cable.
4. Disconnect water inlet hose and exhaust system.
5. Disconnect any ground wires or accessories that are connected to engine.
6. Disconnect audio warning system tan/blue wire as shown.

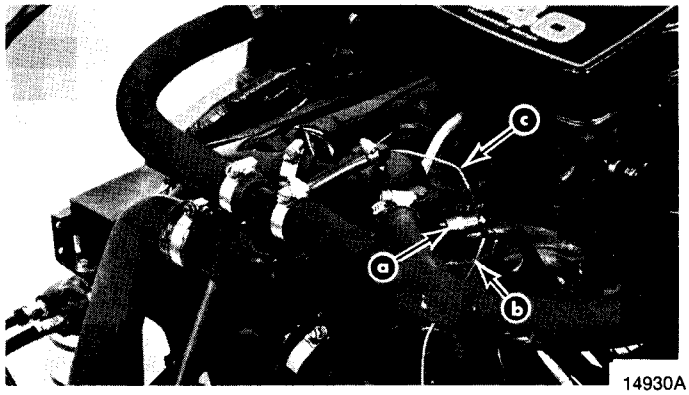
MIE 230/260/5.7L



15015

a - Water Heat Switch
b - Tan/Blue Wire (Jumper Wire to Engine Oil Pressure Switch)
c - Disconnect Tan/Blue Wire (From Buzzer)

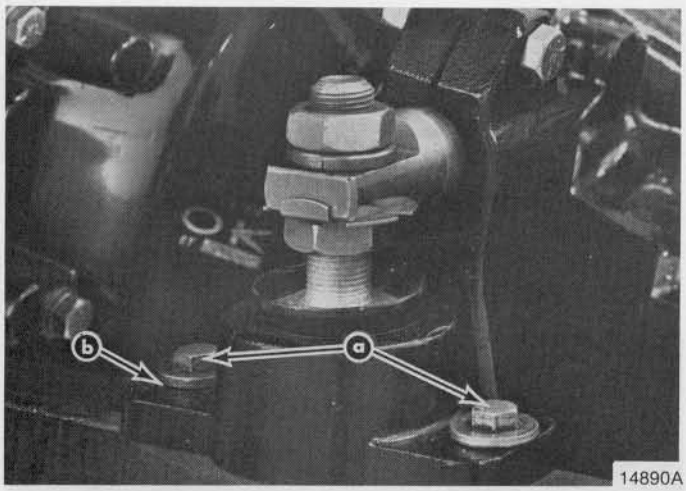
MIE 340



14930A

a - Water Heat Switch
b - Tan/Blue Wire (Jumper Wire to Engine Oil Pressure Switch)
c - Disconnect Tan/Blue Wire (From Buzzer)

7. Disconnect propeller shaft coupling from transmission coupling.
8. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.



a - Bolts
b - Slot Forward

9. Carefully remove engine.

Installation

1. Ensure that all mounts are:
   a. In the center of their up-and-down adjustment.
   b. Slot forward.
   c. Large diameter of mount trunnion extended as shown.
   d. Each mount base is downward. Tighten clamping screws and nuts slightly to prevent moving in or out, but allowed to pivot when installing engine.

a - Slot Forward
b - Locking Nut
c - Adjusting Nut
d - Trunnion Clamping Screw and Nut

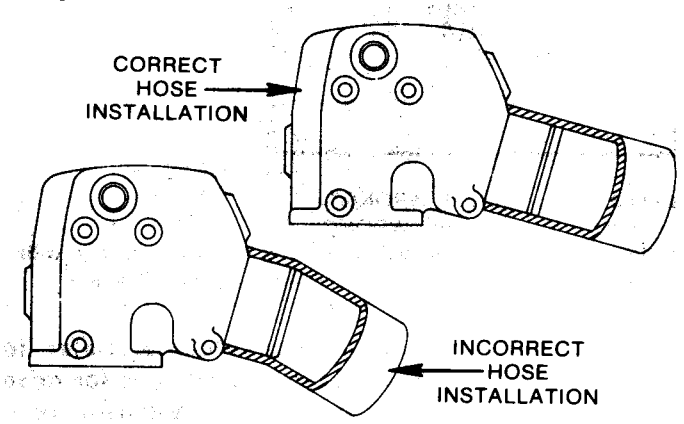
2. Lift engine into boat and position on engine bed so that transmission and propeller shaft couplings are visibly aligned (no gap can be seen between coupling faces when butted together). Adjust engine bed height, if necessary, to obtain proper alignment. Do not use mount adjustment to adjust engine position at this time.

NOTE: Engine bed must position engine so that a minimum of 1/4" (6mm) up-and-down adjustment still exists on all 4 mounts after performing final alignment, following. This is necessary to allow for realigning engine in the future.

3. Check all 4 mounts to ensure that they are still positioned properly, then fasten mounts to engine bed with lag bolts. Tighten securely.
4. Disconnect and remove sling.

5. Connect fuel line. Check for leaks.
6. Connect seawater inlet hose. Tighten clamp securely.
7. Reconnect exhaust system. Tighten clamps securely.
8. Align engine as outlined in "Alignment" before completing installation.
9. After alignment is correct, connect propeller shaft coupling to transmission coupling. Torque bolts and nuts to specifications.

IMPORTANT: Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from the elbow. If hoses are connected incorrectly, discharge water from exhaust elbow will not flow around entire inside diameter of hose. This will cause a hot spot in the hose which may eventually burn thru.

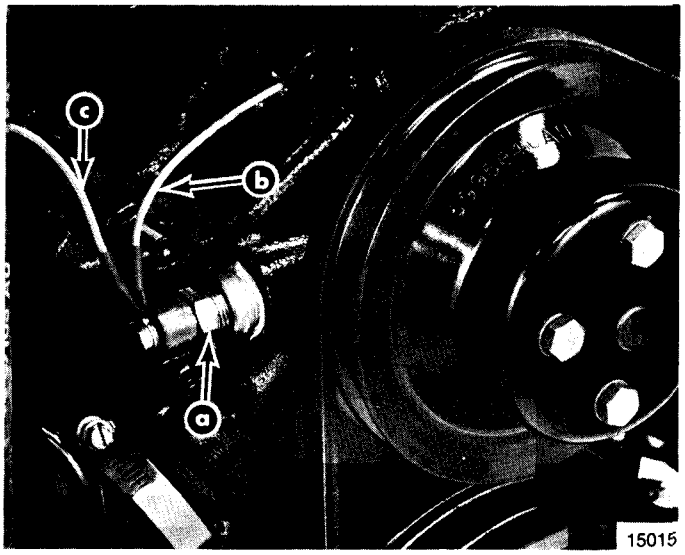


10. Connect instrument harness plug to engine harness receptacle. Tighten clamp securely.
11. Connect the shift cable and throttle cable as outlined in:

    "Attaching/Adjusting Shift Cable".
    "Attaching/Adjusting Throttle Cable".

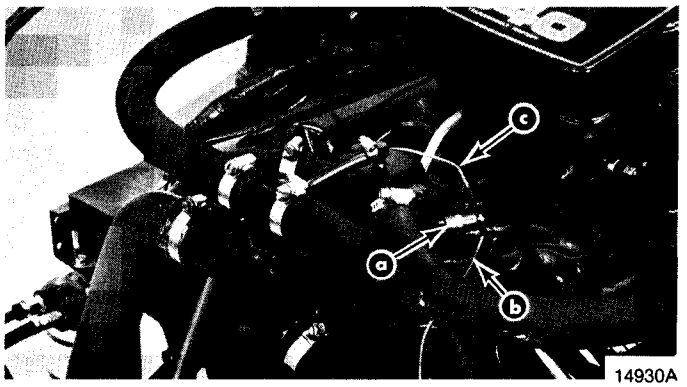
12. Reconnect any ground wire and accessories that may have been disconnected.
13. Connect audio warning system wires.

MIE 230/260/5.7L



a - Water Heat Switch
b - Tan/Blue Wire (Jumper Wire to Engine Oil Pressure Switch)
c - Tan/Blue Wire (From Buzzer)

MIE 340



a - Water Heat Switch
b - Tan/Blue Wire (Jumper Wire to Engine Oil Pressure Switch)
c - Tan/Blue Wire (From Buzzer)

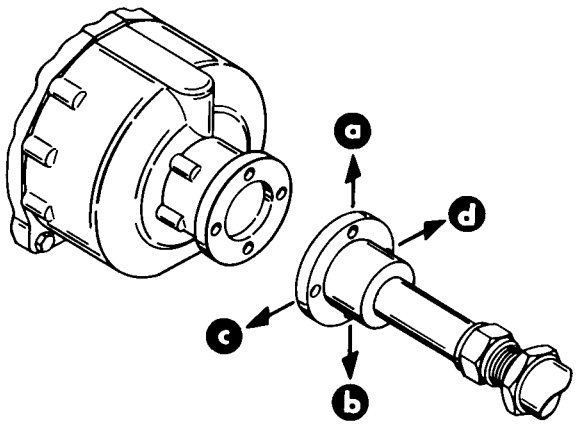
14. Connect battery cables to battery. Tighten securely.

Alignment

IMPORTANT: Engine alignment must be checked with boat in the water, fuel tanks filled and with a normal load onboard.

Engine must be aligned so that transmission and propeller shaft coupling centerlines are aligned and coupling faces are parallel. This applies to installations with solid couplings, as well as flexible couplings. Engine must be properly aligned or vibration, noise and damage to transmission output shaft oil seal and bearings may result.

1. Check mating faces on transmission and propeller shaft couplings to make sure they are clean and flat.
2. Center propeller shaft in shaft log as follows:
   a. Push down and then lift shaft as far as it will move. Then place shaft in the middle of the movement.
   b. Move shaft to port and then to starboard as far as shaft will move. Then place shaft in the middle of the movement.
   c. With shaft in center of shaft log, align engine to shaft.

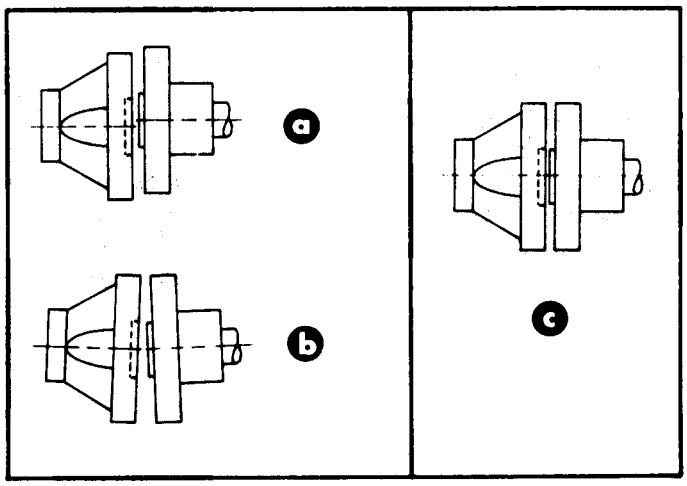


648-H

a - Up
b - Down
c - Port
d - Starboard

3. Check that coupling centerlines align, by butting propeller shaft coupling against transmission coupling. Shoulder on propeller shaft coupling face should engage recess on transmission coupling face with no resistance.

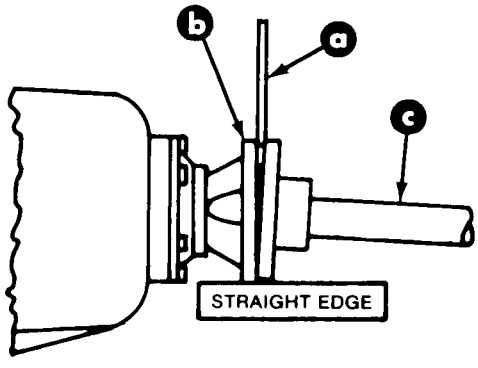
NOTE: Some propeller shaft couplings may not have a shoulder on mating face. On these installations, use a straight edge to check centerline alignment.



a - Offset Misalignment "WRONG"
b - Angular Misalignment "WRONG"
c - Perfect Alignment "RIGHT" Coupling Faces are Parallel with Distance Between Faces Exactly the Same at All Points

IMPORTANT: Remote V-Drive Models: Refer to Remote V-Drive manufacturers instructions for drive shaft (between transmission and remote V-Drive) Alignment.

4. Check for angular misalignment, by hand holding coupling faces tightly together and checking for a gap between coupling faces with a .003" (.07mm) feeler gauge at 90° intervals.

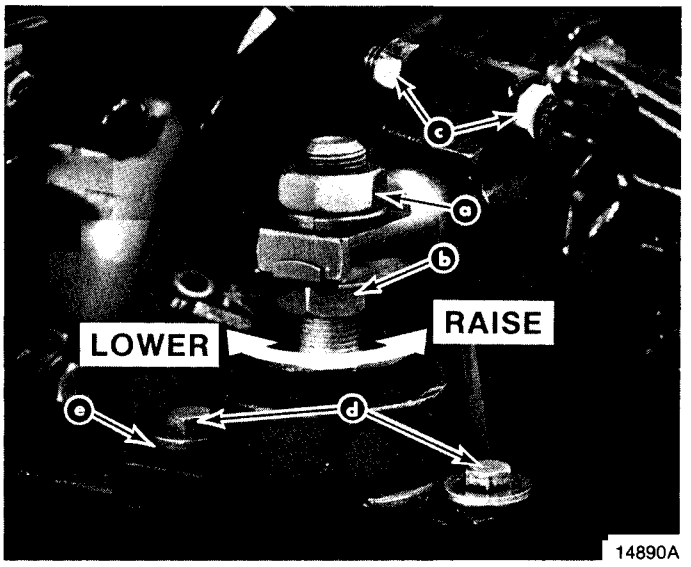


a - Feeler Gauge
b - Transmission Coupling
c - Propeller Shaft

5. If coupling centerlines are not aligned or if coupling faces are more than .003" out-of-parallel, adjust engine mounts, as follows:

   a. TO ADJSUT ENIGNE UP OR DOWN. Loosen locking nut on mounts requiring adjustment. Raise or lower engine using adjusting nut.

IMPORTANT: Both front mounts must be adjusted equally and both rear mounts must be adjusted equally to keep engine level from side-to-side.

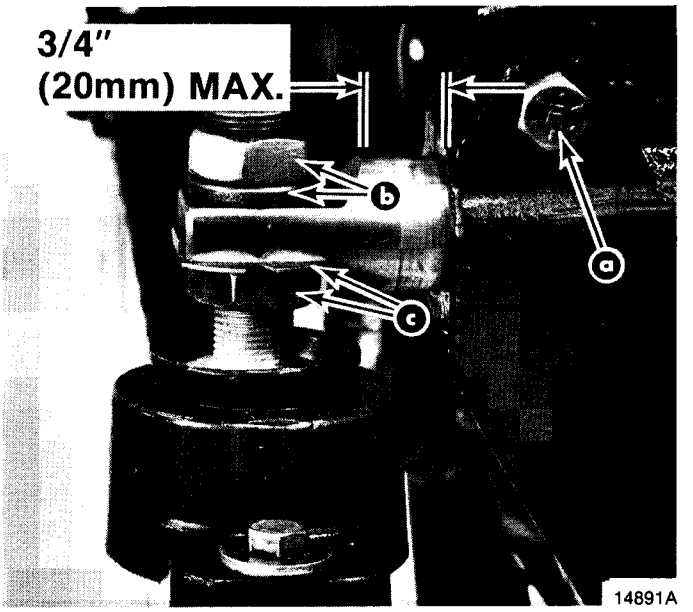


a - Locking Nut
b - Adjusting Nut
c - Clamping Screw and Nut
d - Lag Screws
e - Slot

   b. TO MOVE ENGINE TO THE LEFT OR RIGHT. Loosen clamping screw and nut on all 4 mount brackets and move engine to the left or right, as necessary, to obtain proper alignment. If additional right or left adjustment is needed, a small amount of adjustment can be obtained with slot on front end of mounts. Loosen lag bolts which fasten mounts to engine bed and move engine to the right or left as required. Retighten lag bolts securely.

IMPORTANT: Large diameter of mount trunnion must not extend over 3/4" (20mm) from mount brackets on any of the mounts.

6. After engine has been properly aligned, secure engine mounts, as shown.

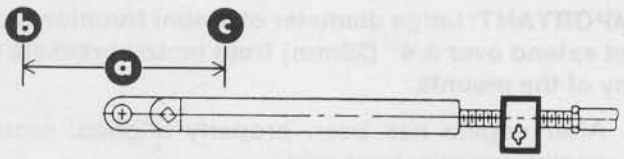


a - Torque Clamping Screw and Nut on All 4 Mount Brackets to Specifications
b - Tighten Locking Nut on All 4 Mounts Securely (Until Lockwasher is Compressed)
c - Bend One of the Tabs on Tab Washer Down onto Flat of Adjusting Nut, to Prevent Nut from Loosening During Operation

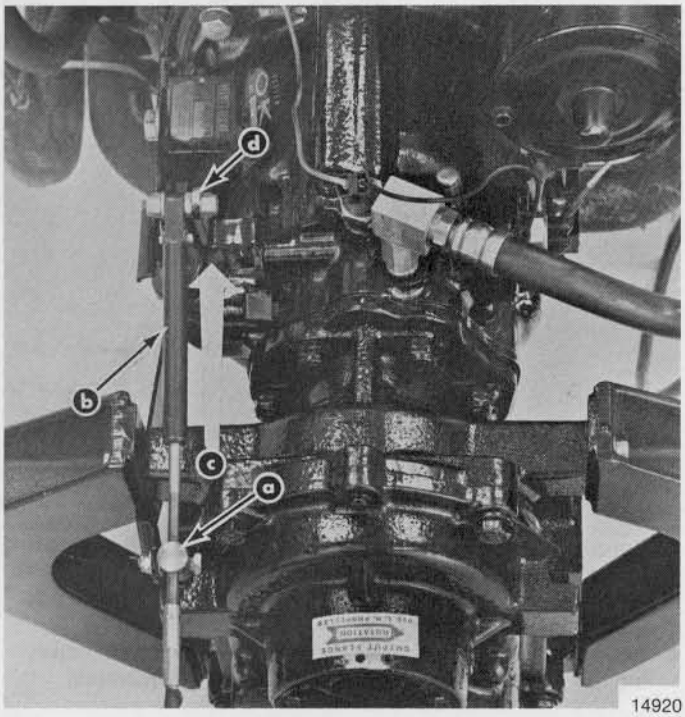
7. Connect propeller shaft coupling to transmission coupling. Torque coupling attaching screws and nuts to specifications.

Attaching/Adjusting Standard Attachment Shift Cable

Remote control must provide a total shift cable travel (at transmission end) of at least 2-3/4" (70mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.



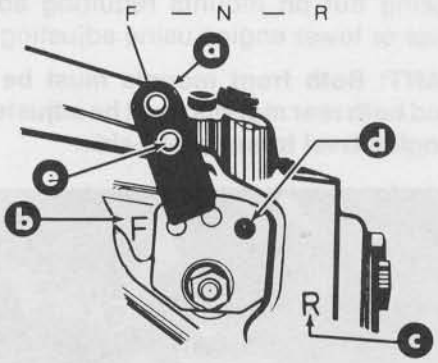
a - 2-3/4" (70mm) Minimum
b - Forward Gear
c - Reverse Gear



14920

a - Cable Brass Barrel (Does Not Move)
b - Cable End Guide (Does Move, Inner Core Wire Extends)
c - Cable End Guide MUST Move in This Direction When Remote Control is Shifted into Forward Gear Position
d - Transmission Shift Lever

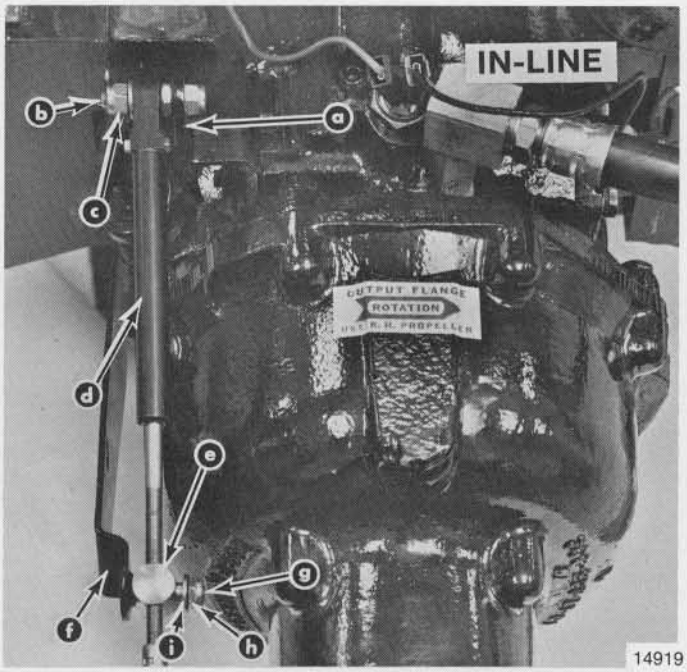
IMPORTANT: Remote control and shift cable must position transmission shift lever exactly as shown, or transmission failure may occur. Do not remove poppet ball or spring.



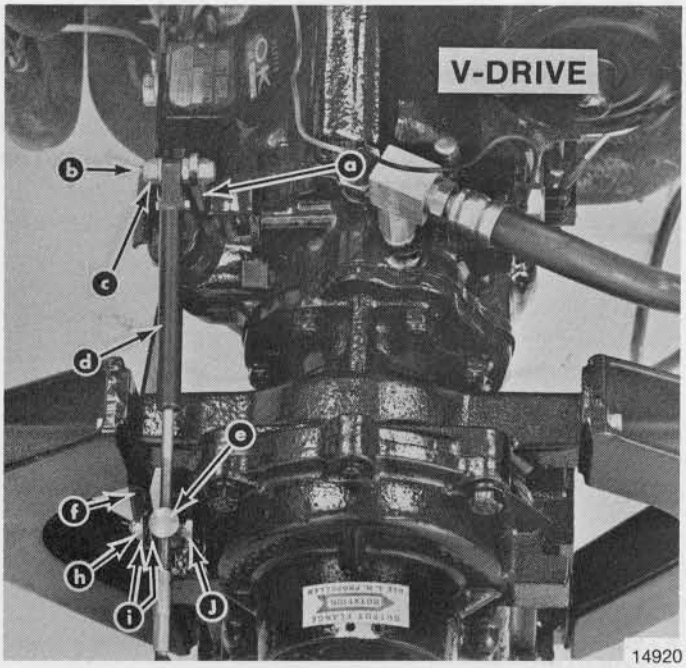
a - Transmission Shift Lever
b - Shift Lever Must Be Over This Letter When Propelling Boat FORWARD
c - Shift Lever Must Be Over This Letter When Propelling Boat in REVERSE
d - Poppet Ball Must Be Centered in Detent Hole for Each F-N-R Position (Forward Gear Shown)
e - Install Shift Lever Stud in This Hole, If Necessary, To Center Poppet Ball in Forward and Reverse Detent Holes

Single Station Mounting

1. Place remote control shift lever in neutral position.
2. Place transmission shift lever in neutral.
3. Adjust brass barrel on shift cable, as required, to align shift cable attaching holes with shift lever stud and shift cable bracket stud or screw hole. Center cable end play travel when making adjustment.
4. Install shift cable and secure as shown. Tighten nut that secures cable end guide until it bottoms out, then back off 1/2-turn. Tighten nut that secures brass barrel securely.



14919

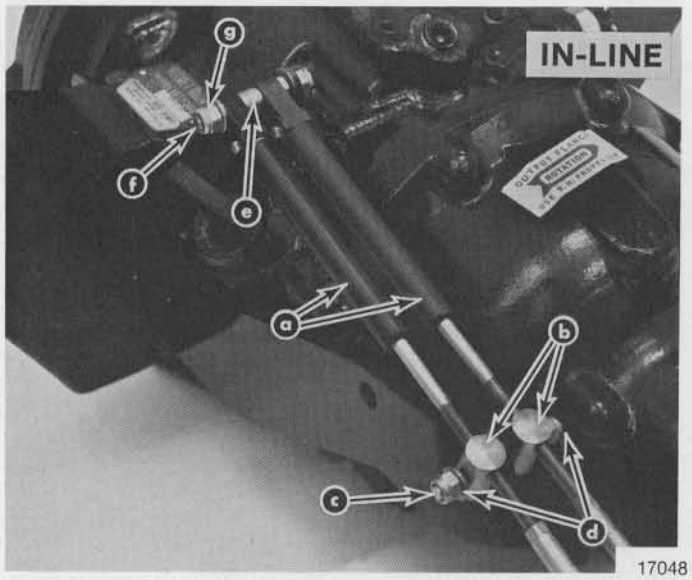


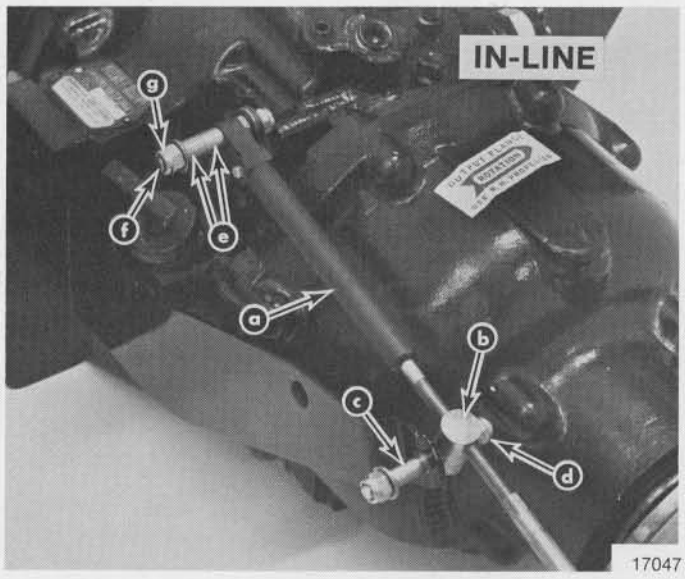
a - Shift Lever
b - Shift Lever Stud
c - Elastic Stop Nut (Thick) and Flat Washer
d - Cable End Guide
e - Cable Brass Barrel
f - Shift Cable Bracket
g - Anchor Stud (In-Line Transmission)
h - Elastic Stop Nut (Thin)
i - Flat Washer
j - Anchor Screw (V-Drive)

5. Place remote control shift lever in full forward gear position. Check position of transmission shift lever.
6. Place remote control lever in full reverse gear position and again check shift lever position.
7. If transmission shift lever is positioned correctly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever is not positioned properly in both gears, move shift lever stud from top hole in shift lever to bottom hole and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.

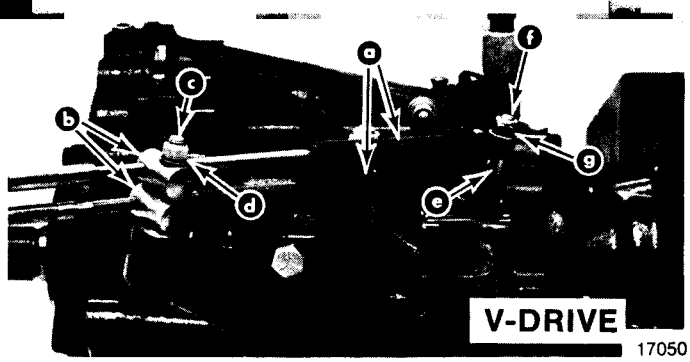
Dual and Single Station Mounting

1. Place remote control shift lever in neutral position.
2. Place transmission shift lever in neutral position.
3. Adjust brass barrel on shift cable to align holes in brass barrel and cable end guide with attaching points on transmission. Center cable end play travel when making adjustment.
4. Install shift cable, as shown. Tighten "g" until it bottoms out, then back off 1/2-turn. Cable end guide must be free to pivot. Tighten "d" securely.





a - Cable End Guide
b - Cable Brass Barrel
c - Anchor Stud
d - Elastic Stop Nut and Washer
e - Spacer
f - Shift Lever Stud
g - Elstic Stop Nut and Washer



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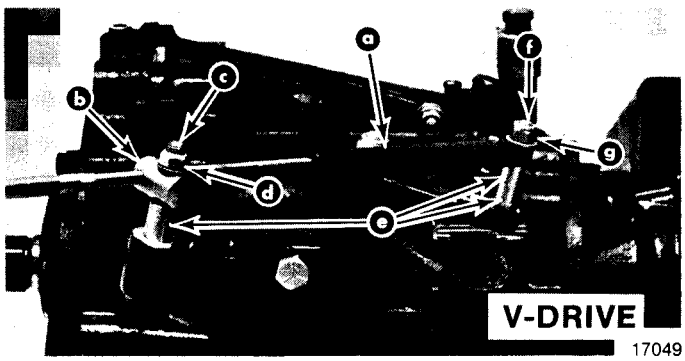
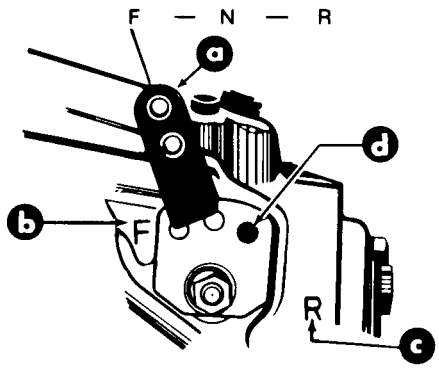


17049

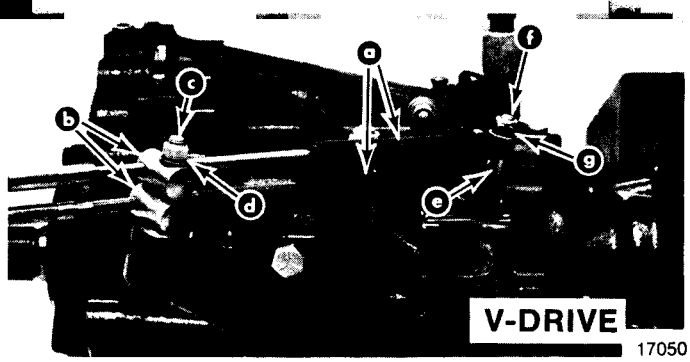
a - Cable End Guide
b - Cable Brass Barrel
c - Anchor Stud
d - Elastic Stop Nut and Washer
e - Spacer
f - Shift Lever Stud
g - Elstic Stop Nut and Washer

5. Place remote control shift lever in forward gear position and check position of transmission shift lever. Shift lever must be positioned as shown.
6. Place remote control lever in reverse gear position and again check shift lever position. Lever must be positioned as shown in (c).



a - Transmission Shift Lever
b - Shift Lever Must Be Over This Letter When Propelling Boat FORWARD
c - Shift Lever Must Be Over This Letter When Propelling Boat in REVERSE
d - Poppet Ball Must Be Centered in Detent Hole for Each F-N-R Position (Forward Gear Shown)

7. If transmission shift lever is positioned properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever is not positioned properly in both gears, move transmission shift lever stud from top hole in shift lever to bottom hole and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



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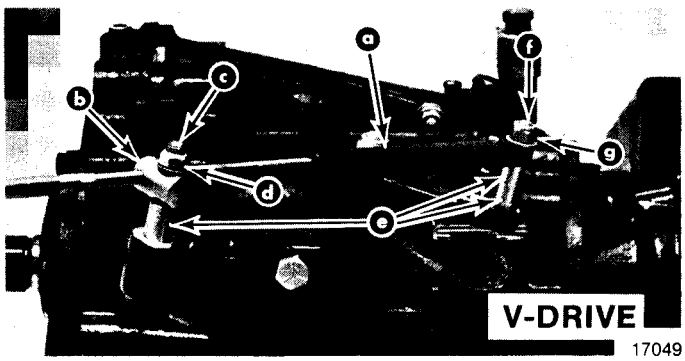
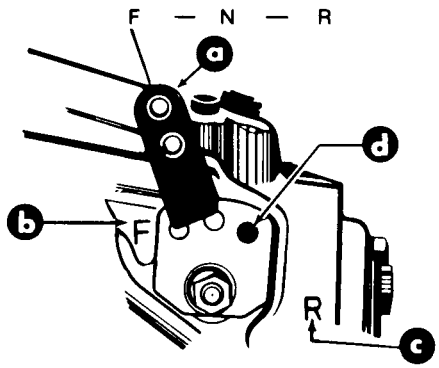


17049

a - Cable End Guide
b - Cable Brass Barrel
c - Anchor Stud
d - Elastic Stop Nut and Washer
e - Spacer
f - Shift Lever Stud
g - Elstic Stop Nut and Washer

5. Place remote control shift lever in forward gear position and check position of transmission shift lever. Shift lever must be positioned as shown.
6. Place remote control lever in reverse gear position and again check shift lever position. Lever must be positioned as shown in (c).



a - Transmission Shift Lever
b - Shift Lever Must Be Over This Letter When Propelling Boat FORWARD
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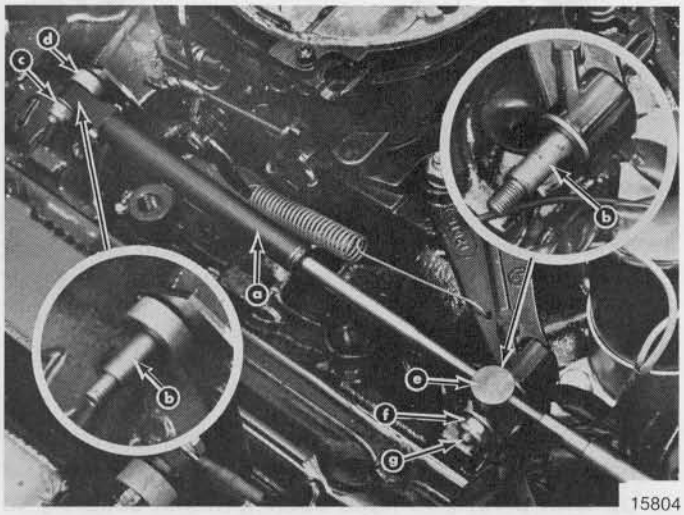
d - Poppet Ball Must Be Centered in Detent Hole for Each F-N-R Position (Forward Gear Shown)

7. If transmission shift lever is positioned properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever is not positioned properly in both gears, move transmission shift lever stud from top hole in shift lever to bottom hole and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.

Attaching/Adjusting Throttle Cable

Single Station Mounting

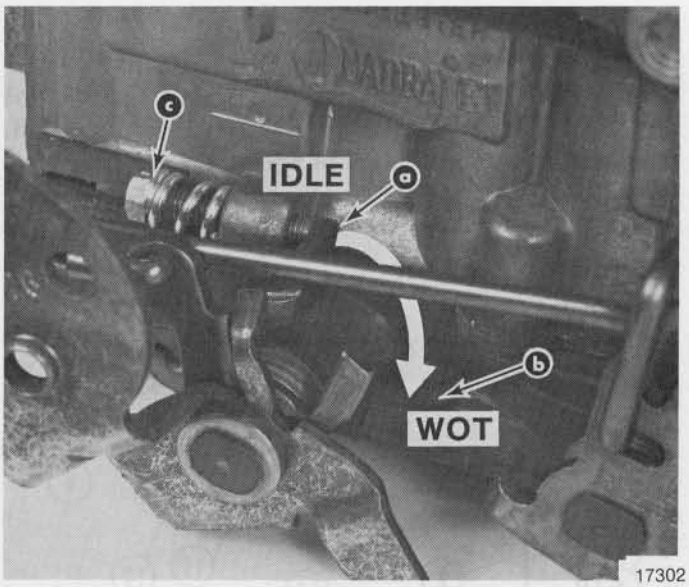
1. Place remote control lever in neutral idle position.
2. Install throttle cable end guide on throttle lever screw. Grasp cable behind brass barrel and push lightly toward throttle lever, then adjust brass barrel to align hole with throttle cable anchor stud (and spacer) and slide barrel onto stud.
3. Secure brass barrel and cable end guide with flat washers and elastic stop nuts. Tighten cable attaching nuts securely, but do not over-tighten, because anchor points must be free to pivot.



15804

a - Cable End Guide
b - Bushing
c - Washer, Nut and Screw (Do Not Over-Tighten)
d - Spacer
e - Brass Barrel
f - Washer and Nut (Do Not Over-Tighten)
g - Anchor Stud

4. Place remote control throttle lever in the full throttle position and check that carburetor throttle plates open fully and throttle lever contacts stop. If they do not, check throttle cable and linkages for binding. Return remote control to neutral, idle position and check that carburetor throttle lever returns to idle position and throttle plates are fully closed.



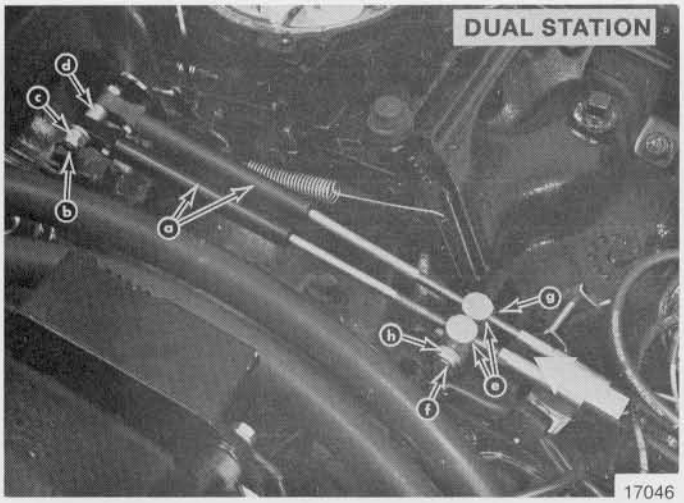
17302

a - Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

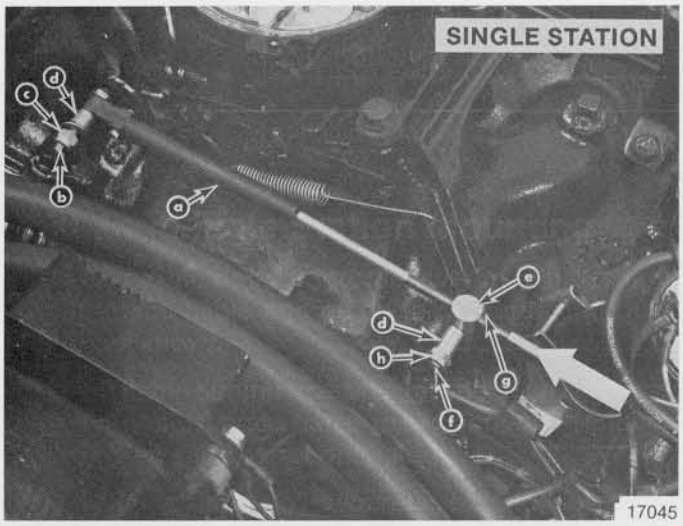
Dual and Single Station Mounting

1. Place remote control throttle lever in idle position and attach cable end guide to carburetor throttle lever as shown.
2. Grasp cable behind brass barrel and push lightly as shown. Adjust brass barrel to align hole with anchor stud, then slide barrel onto stud.
3. Tighten "c" and "h" securely, but do not over-tighten.

DUAL STATION

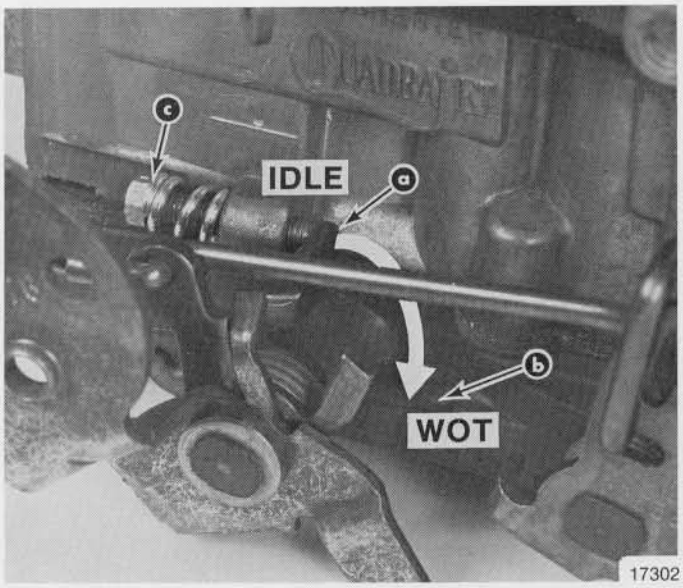


SINGLE STATION



a - Cable End Guide
b - Throttle Lever Stud
c - Elastic Stop Nut and Washer
d - Spacer
e - Cable Brass Barrel
f - Anchor Stud
g - Washer
h - Elastic Stop Nut

4. Place remote control throttle lever in the full throttle position and check that carburetor throttle plates open fully and throttle lever contacts stop. If they do not, check throttle cable and linkages for binding. Return remote control to netural, idle position and check that carburetor throttle lever returns to idle position and throttle plates are fully closed.

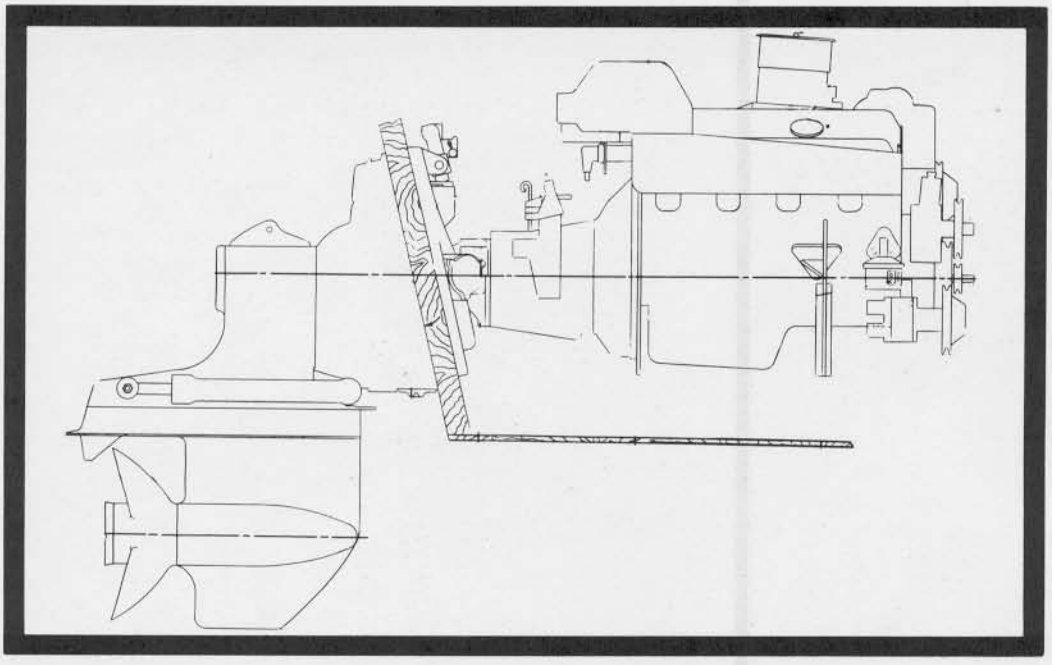


a - Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

REMOVAL and INSTALLATION

2

F



MODELS with BRAVO DRIVES

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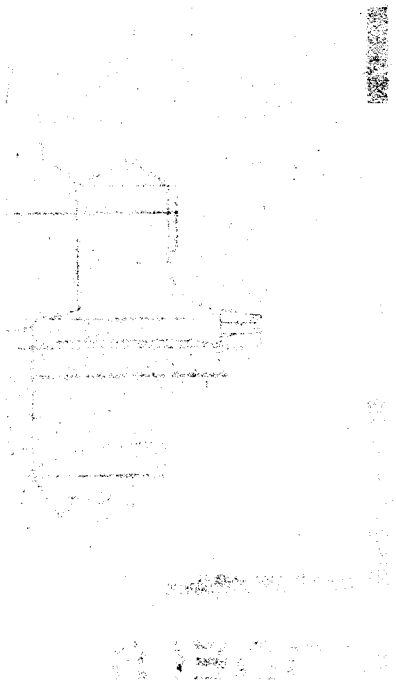
AVON



TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Drive Unit Shift Cable		
Brass Barrel	Spread Cotter Pin	
Cable End Guide	(Note 1)	
Front Engine Mount	Securely	
Hose Clamps	Securely	
Power Steering Fluid Hose Fittings		
Large	20-25 (27-34)	
Small		96-108 (11-12)
Rear Engine Mounts	35-40 (47-54)	
Remote Control Shift Cable		
Brass Barrel	Securely	
Cable End Guide	(Note 1)	
Remote Control Throttle Cable		
Brass Barrel	Securely	
Cable End Guide	(Note 1)	

NOTE: Tighten, then back nut off 1/2 turn.

TOOLS/LUBRICANTS

TOOLS/LUBRICANTS	
91-57797A3	Engine Alignment Tool
92-86154A1	Quicksilver 2-4-C Marine-Lube

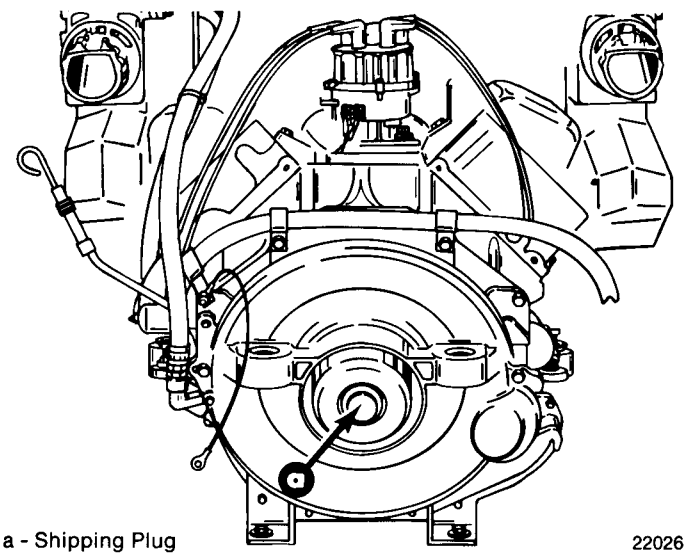
Removal

IMPORTANT: Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual".

1. Disconnect battery cables from battery and remove instrument harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Disconnect trim position sender wires (coming from gimbal housing) from terminal block on circuit breaker/solenoid mounting bracket. After wires are disconnected, remove wires from clamps that hold the power steering hoses.
4. Remove red and black Power Trim pump motor wires from engine (some models).
5. Disconnect water inlet hose and exhaust elbow bellows.
6. Remove both shift cables from shift plate.
7. Disconnect any grounding wire or accessories that are connected to the engine.
8. **Power Steering Models:** Disconnect fluid hoses from power steering control valve.
9. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.
10. Carefully remove engine.

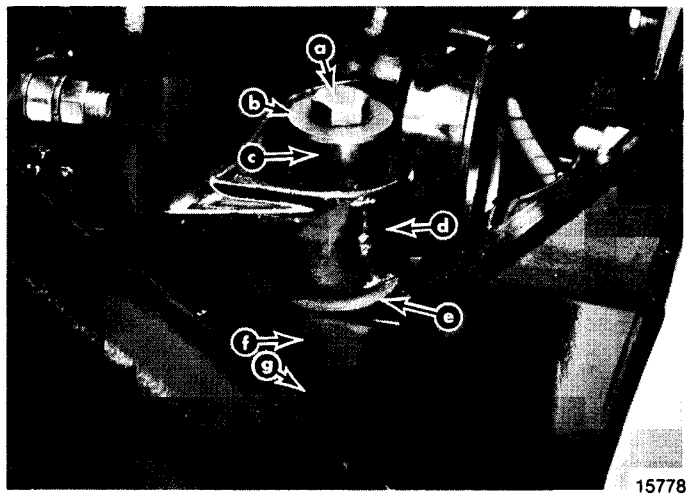
Installation

1. Lift engine with an overhead hoist, using suitable sling and lifting eyes on engine.
2. Remove shipping plug and lubricate splines with 2-4-C Marine Lubricant.



a - Shipping Plug 22026

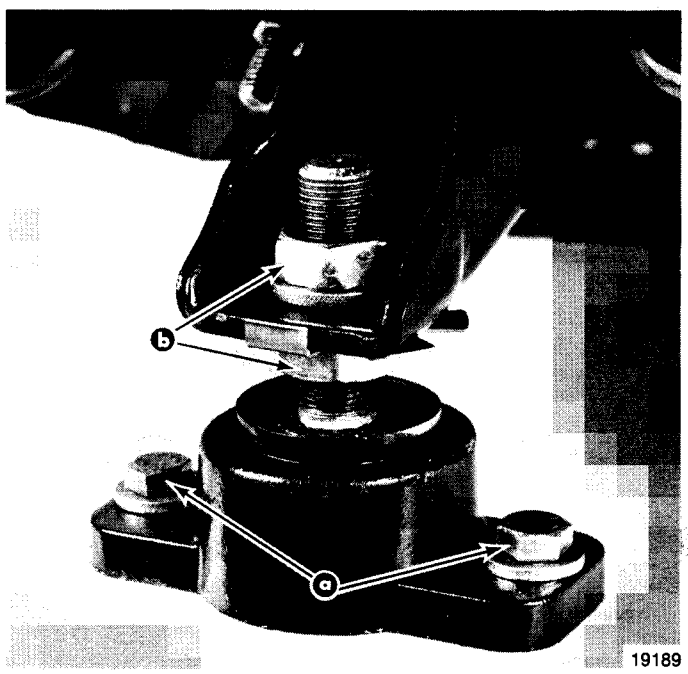
3. Place large fiber washer on top on transom plate engine mounting bracket and double wound lockwasher inside fiber washer.
4. Place engine over transom plate mounting brackets, hose clamps over rubber exhaust elbow bellows.
5. Place steel washers and spacers on mounting bolts and insert bolts down thru rear engine mounts, washers and mounting brackets. Thread elastic stop nuts on bolts. Torque to specifications.



15778

a - Rear Engine Mounting Bolts
b - Large Steel Washer
c - Metal Spacer
d - Rear Engine Mount
e - Fiber Washer With Double Wound Lockwasher in the Center
f - Mounting Brackets
g - Elastic Stop Nut (Hidden)

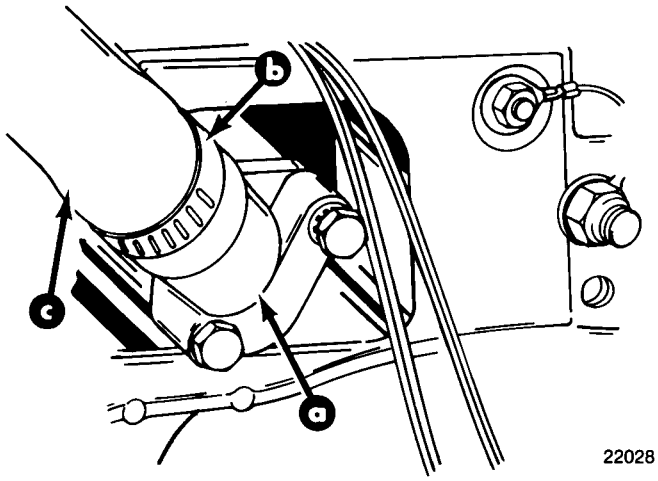
6. Tighten all exhaust bellow clamps securely.
7. Secure front engine mounts to boat.
8. Check engine alignment. Refer to "Alignment". After correct alignment is attained, tighten locknuts securely.



19189

a - Mounting Bolts
b - Locking Nuts

9. Place hose clamp over water inlet hose and place hose over inlet tube. Tighten clamp securely.

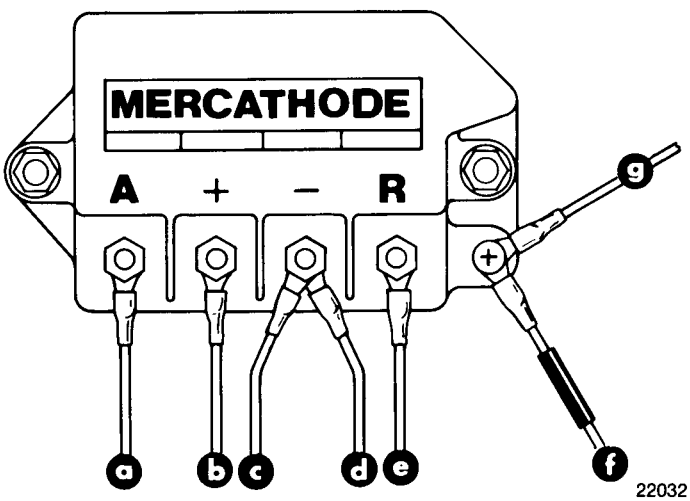


22028

a - Water Pickup Outlet
b - Hose Clamp (Tighen Securely)
c - Water Hose

10. Connect instrument harness to engine harness. Secure with clamp and tighten securely.

11. Connect trim position sender wires as follows:



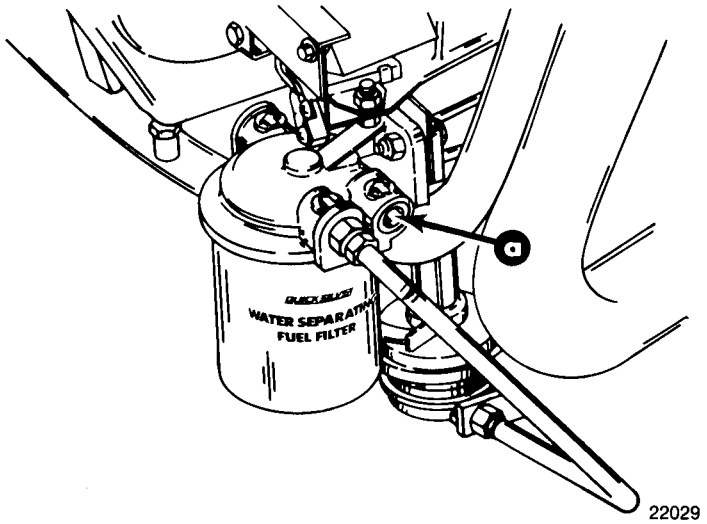
22032

a - Orange Lead - From Electrode on Transom Assembly
b - Red/Purple Lead - Connected (Other End) to Positive (+) Battery Terminal
c - Black Lead - From Engine Harness
d - Trim Position Sender Lead **Without** Sleeve
e - Brown Lead - From Electrode on Transom Assembly
f - Trim Position Sender lead with Brown or Purple Sleeve
g - Brown/White Lead - From Engine Harness

⚠CAUTION

Use Loctite Pipe Sealant with Teflon on threads of fitting going into fuel pump or water separating fuel filter. Do not use Teflon tape.

12. Connect fuel line.

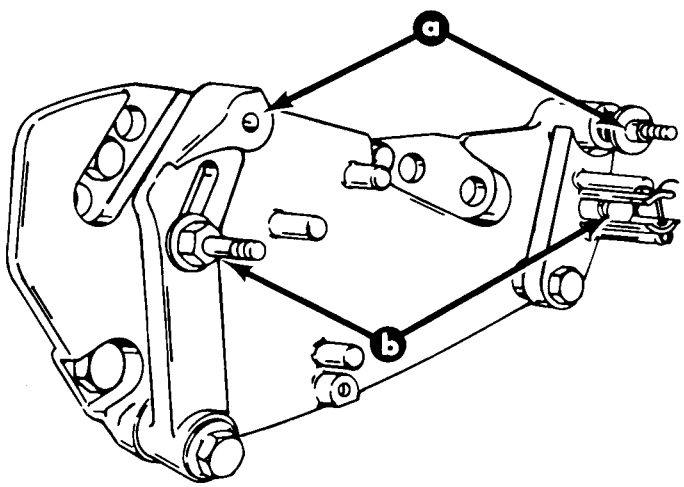


22029

a - Remove Shipping Plug and Connect Flexible Fuel Line Here - Torque to 10-18 lb. ft. (14-24 N.m)

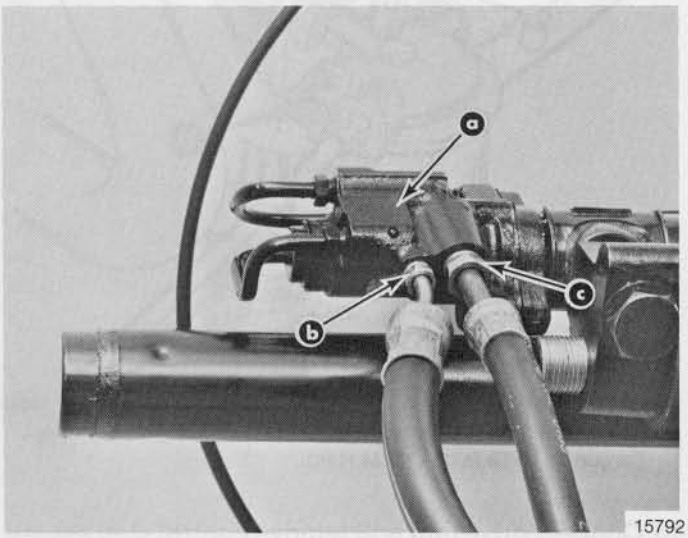
13. Connect drive unit and remove control shift cables as follows:

IMPORTANT: Adjust shift cables as outlined in "Stern Drive Service Manual".



a - Remote Control Shift Cable Anchor Points
b - Drive Unit Shift Cable Anchor Points

14. Connect throttle cable. Refer to "Attaching/Adjusting throttle Cable".
15. Connect red and black trim pump wires (some models).
16. Connect any ground wires or accessories that may have been disconnected.
17. **Power Steering Models:** Reconnect fluid hoses as shown.



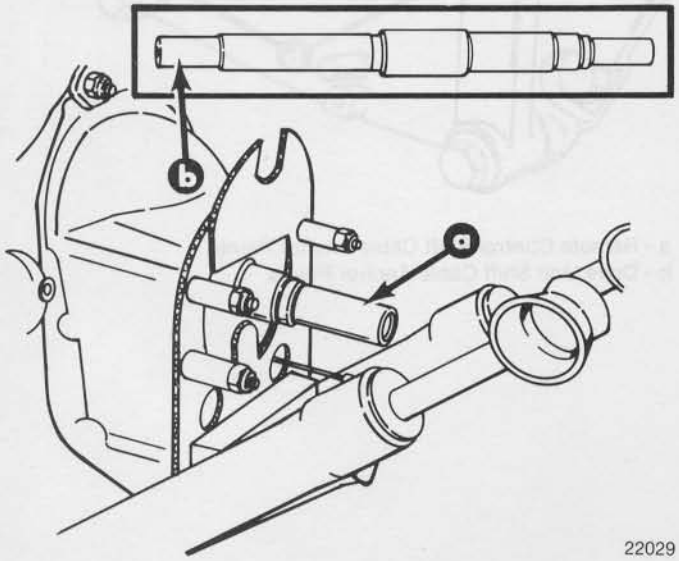
a - Control Valve
b - Small Fitting — Torque to Specifications
c - Large Fitting — Torque to Specifications

IMPORTANT: Bleed power steering system as outlined in "Stern Drive Service Manual".

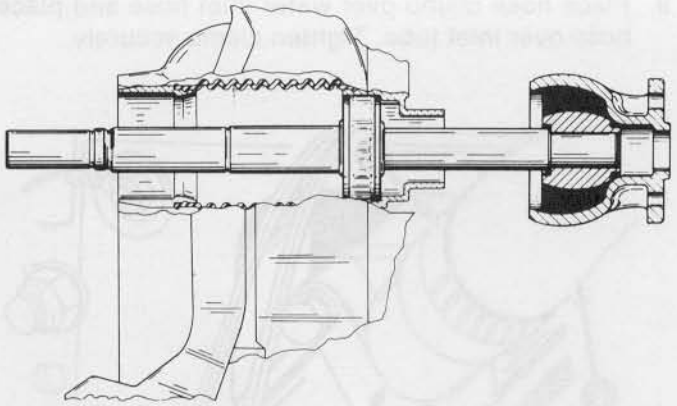
18. Connect battery cables to battery.

Alignment

1. Using Alignment Tool (91-57797A3), insert end of shaft (which does not have threaded hole) thru gimbal bearing. Move gimbal bearing, as required, to insert shaft into engine coupling.



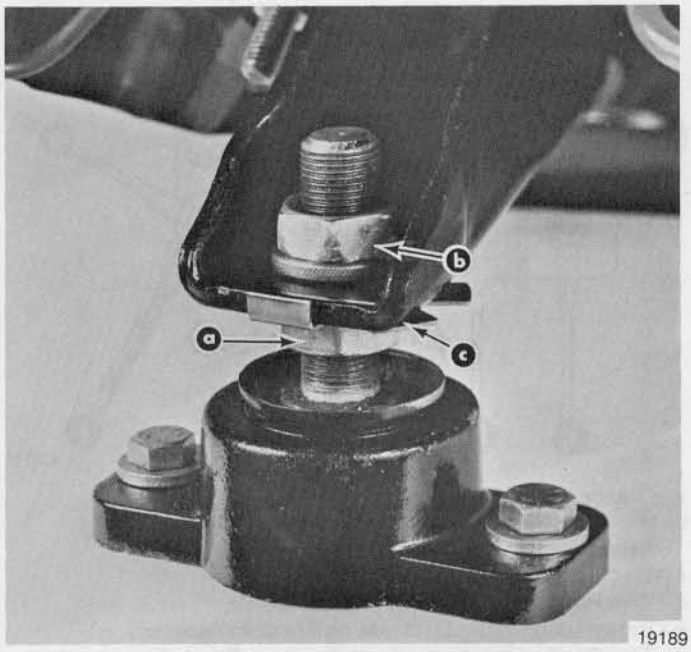
a - Alignment Tool
b - Insert this End of Alignment Tool thru Gimbal Housing Assembly



2. If shaft enters coupling freely with no pressure, alignment is correct. If not, proceed as follows:
   a. Loosen locknut on both front engine mounts.
   b. Thread adjusting nut either way to raise or lower front of engine.

IMPORTANT: Raise or lower each side of of the engine the same amount. Care must be taken not to "cock" front of engine.

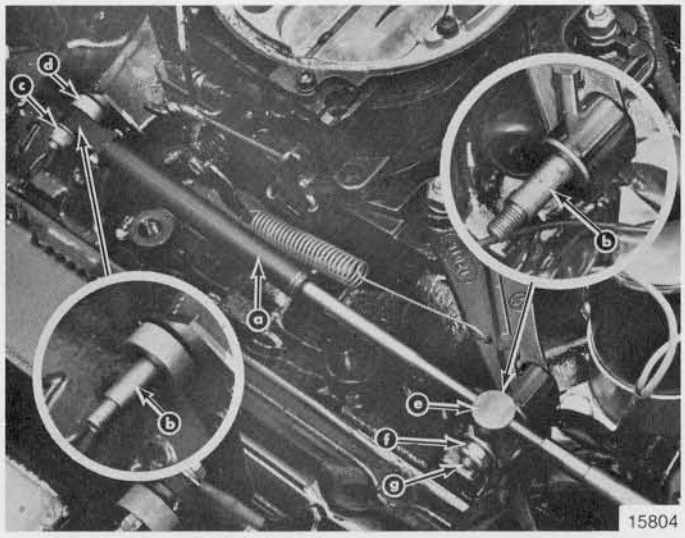
   c. After correct alignment shaft fit is attained, tighten locknuts securely. Recheck alignment shaft fit.



a - Turn Both Front Engine Mounts an Equal Amount in Direction Required Until Alignment Shaft Enters Engine Coupling Freely
b - Locknut
c - Tab Washer

Attaching/Adjusting Throttle Cable

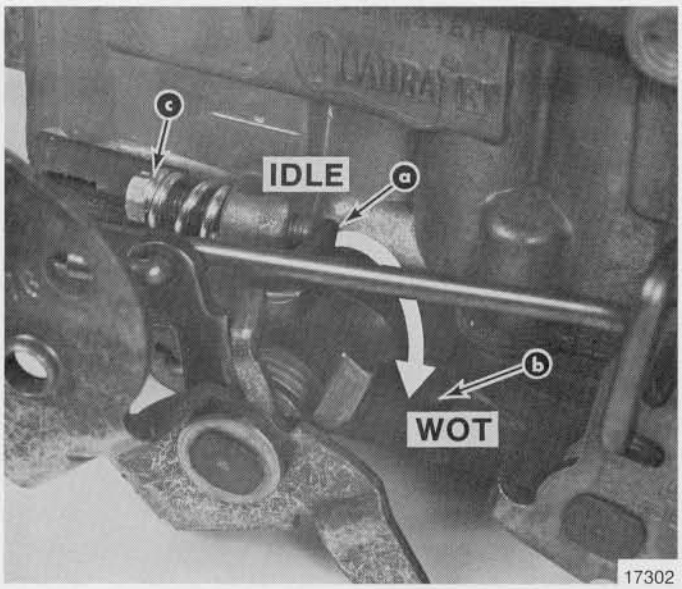
1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel as shown.



15804

a - Cable End Guide
b - Bushing
c - Washer, Nut and Screw (DO NOT Over-Tighten)
d - Spacer
e - Brass Barrel
f - Washer and Nut (DO NOT Over-Tighten)
g - Anchor Stud

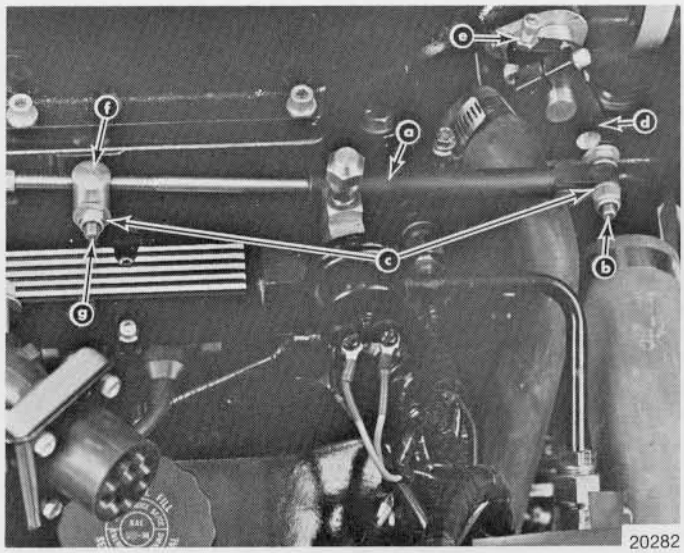
4. Check that throttle valves are fully open when remote control is at full throttle position. Level tang should be against stop.
5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop.



17302

a - Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

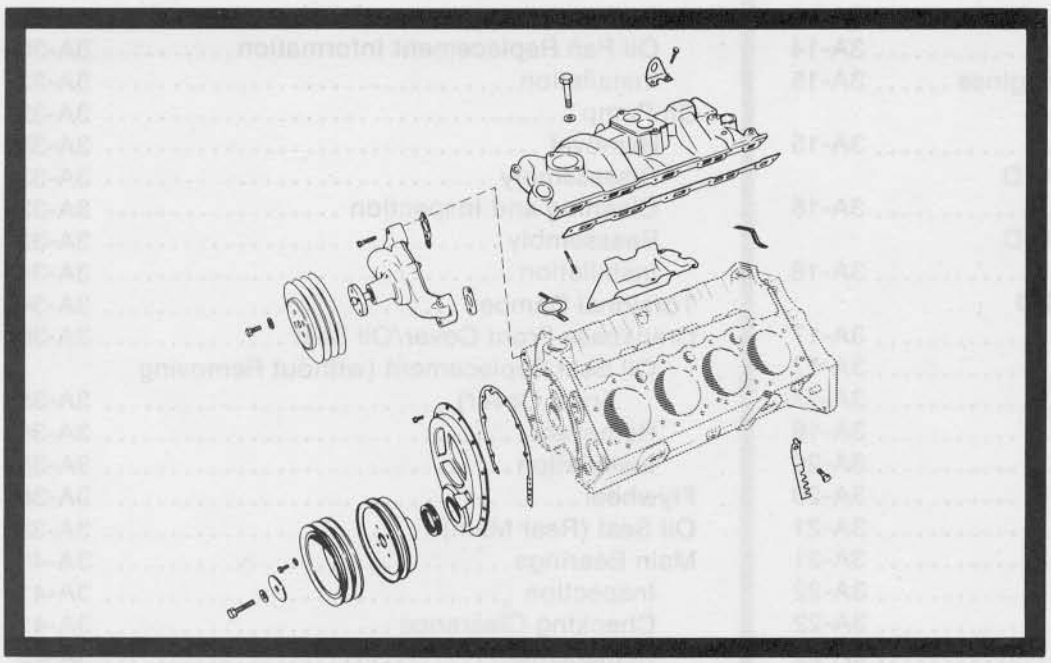
320 EFI



20282

a - Cable End Guide
b - Throttle Lever Stud
c - Elastic Stop Nut and Flat Washer
d - Throttle Lever
e - Idle Speed Adjustment Screw (Must Contact Idle Speed Stop Screw)
f - Brass Barrel
g - Throttle Cable Anchor Stud

ENGINE



V-8 GM 305/350 CID

3

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NOTICE

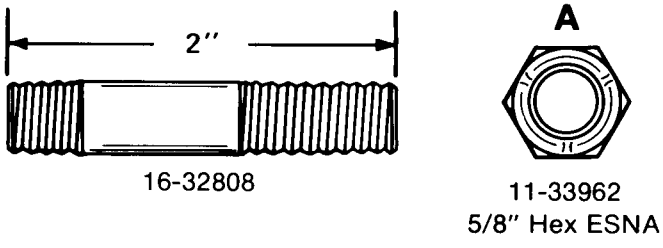
The repair procedures in this manual can be used for repairing Production Performance engines. It is recommended that only mechanics familiar with hi-performance engines attempt the repairs.

Torque Specifications
305 and 350 CID Engines

Fastener Location	305 and 350 CID		350 CID Production Performance	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace to Alternator		192 (28)		192 (28)
Alternator Brace to Block	30 (41)		30 (41)	
Alternator to Mounting Bracket	35 (48)		35 (48)	
Alternator Mounting Bracket	30 (41)		30 (41)	
Camshaft Sprocket/Gear	20 (27)		20 (27)	
Carburetor		132 (15)		132 (15)
Connecting Rod Cap	45 (61)		45 (61)	
Coupler/Flywheel (MCM)	See Page 3			
Crankshaft Damper	60 (81)		70 (95)	
Crankshaft Pulley	35 (48)		35 (48)	
Cylinder Head	65 (88)		75 (102)	
Distributor Hold Down	25 (34)		20 (27)	
Exhaust Manifold	20 (27)		20 (27)	
Flywheel (MIE)	60 (81)		60 (81)	
Flywheel Drive Plate (MIE)	35 (48)		35 (48)	
Flywheel Housing to Block	30 (41)		30 (41)	
Flywheel Housing Cover		80 (9)		80 (9)
Front Mount Bracket	30 (41)		30 (41)	
Fuel Pump	30 (41)		30 (41)	
Intake Manifold	30 (41)		35 (48)	
Intake Top (EFI)			6 (8)	
Fuel Rail (EFI)				30 (3)
Main Bearing Cap Long Bolt	80 (109)		75 (102)	
(Production Performance Only) Short Bolt			70 (95)	
Oil Filter Bypass Valve		80 (9)		80 (9)
Oil Pan Plug	20 (27)		20 (27)	
Oil Pan Screw (1/4"-20)		80 (9)		80 (9)
Oil Pan Screw (5/16"-18)		165 (19)		165 (19)
Oil Pump	65 (88)		65 (88)	
Oil Pump Cover		80 (9)		80 (9)
Power Steering Pump Brace to Block	30 (41)		30 (41)	

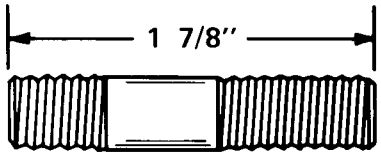
Fastener Location	305 and 350 CID		350 CID Production Performance	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Power Steering Pump Bracket	30 (41)		30 (41)	
Rear Mount (MCM)	40 (54)		40 (54)	
Rear Mount (MIE)	50 (68)		50 (68)	
Remote Oil (1/2"-13)	25 (34)		25 (34)	
Filter Adaptor (5/16"-18)	20 (27)		20 (27)	
Rocker Arm Cover		50 (5.5)		60 (7)
Seawater Pump Brace	30 (41)		30 (41)	
Seawater Pump Bracket	30 (41)		30 (41)	
Spark Plugs		180 (20)		180 (20)
Starter Motor	50 (68)		50 (68)	
Thermostat Housing	30 (41)		30 (41)	
Timing Chain or Gear Cover		80 (9)		80 (9)
Transmission to Housing	50 (68)		50 (68)	
Water Circulating Pump	30 (41)		30 (41)	
Water Temp. Sender	20 (27)		20 (27)	

IMPORTANT: Do not intermix stud/nut combinations.



16-32808

11-33962
5/8" Hex ESNA



16-98532

11/16" Hex
Crownlock

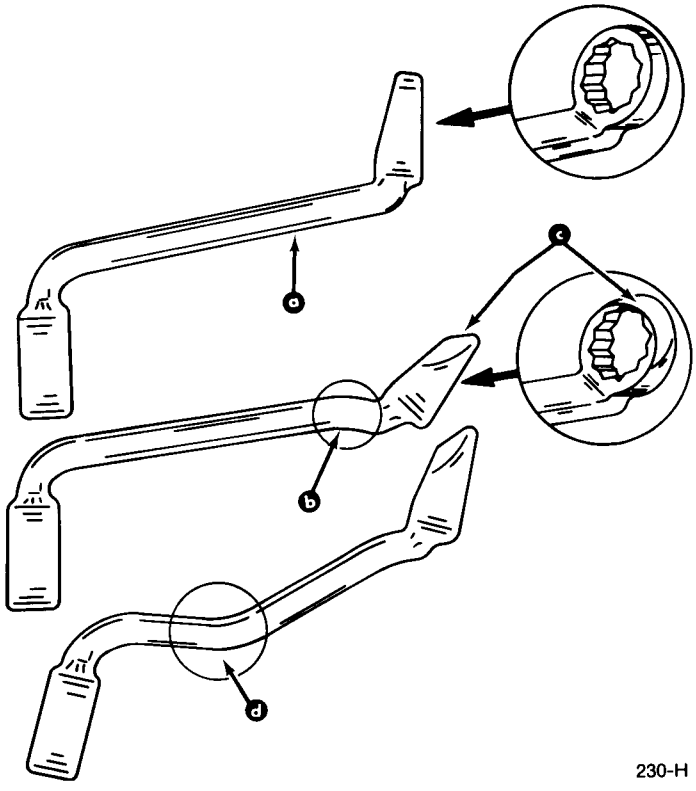
11-98533
5/8" Hex Crownlock

269-H

a - 45 Lbs. Ft. (61 N.m)
b - 35 Lbs. Ft. (42 N.m)
c - 40 Lbs. Ft. (54 N.m)
d - See Figure 2 for Coupler Wrench Modification

Engine Coupler/Flywheel

Engine Coupler Wrench, 91-35547, may not work on the later couplers. Modify wrench as shown, so it will work on both earlier and later style couplings.



230-H

a - Original 91-35547 Wrench
b - Heat and Bend as Shown
c - Grind Area Shown Slightly
d - Heat and Bend as Shown (This is What Wrench Should Look Like When It's Done)

Modifying Engine Coupler Wrench

Tools/Lubricants/Sealants

MERCURY MARINE SPECIAL TOOLS	
91-24697	Piston Ring Expanders
91-35547	Engine Coupler Wrench
91-66273	Rocker Stoppers

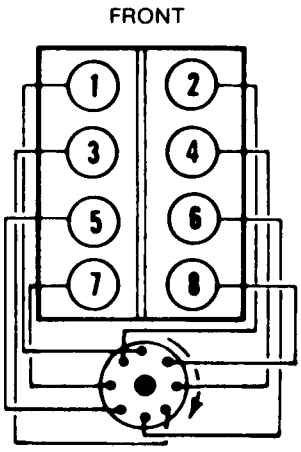
KENT-MOORE SPECIAL TOOLS Can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500	
J5892	Valve Spring Compressor
J8062	Valve Spring Compressor
J8056	Valve Spring Tester
J8101	Valve Guide Cleaner
J5830-2	Valve Guide Reamer
J7049-5	Valve Guide Reamer Set
J5802-01	Rocker Arm Stud Remover
J6880	Rocker Arm Stud Installer
J5715	Rocker Arm Stud Hole Reamer (.003" O.S.)
J6036	Rocker Arm Stud Hole Reamer (.013" O.S.)
J8089	Carbon Remover Brush
J24086-100	Piston Pin Tool
J3936-03	Piston Ring Groove Cleaner
J8037	Piston Ring Compressor
J6305-1	Connecting Rod Bolt Guide Set (11/32" Bolts)
J8369	Oil Pump Suction Pipe Installer
J6098-01	Camshaft Bearing Remover and Installer Tool
J23523-03	Harmonic Balancer Removal and Installer Tool
J23042	Crankcase Front Cover Seal Installer
J1619	Crankshaft Gear and Sprocket Puller
J5590	Crankshaft Gear and Sprocket Installer

LUBRICANTS/SEALANTS	
92-32609-1	Quicksilver Loctite
92-34227	Quicksilver Perfect Seal
92-42649A1	Quicksilver Needle Bearing Assembly Lubricant
92-91601-1	Quicksilver RTV Sealer

Engine Specifications

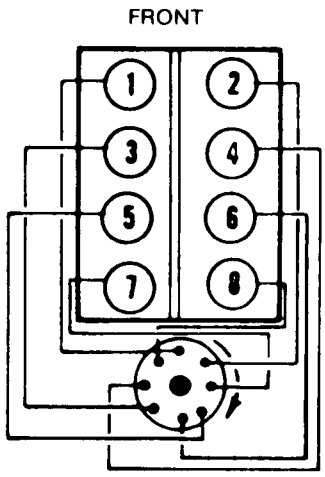
UNIT OF MEASUREMENT
in. (mm)

	200 MCM 5.0 Litre	230 MCM 5.0 Litre LX	230TR MCM	230 MIE 5.0 Litre	260 MCM 5.7 Litre	260TR MCM 5.7 Litre	260 MIE 5.7 Litre	5.7 Ski MIE	350 MCM Magnum	300 MCM Alpha One Tempest	300TRS MCM Tempest
Bore	3.74 (95)				4.00 (101.6)						
Stroke	3.38 (88.4)				3.48 (88.4)						
Cubic Inch Displacement	305 (5L)				350 (5.7L)					350 (5.7L) Production Performance	
Compression Ratio	8.5:1				9.0:1						
Heads	Cast Iron										
Intake Manifold	Cast Iron									Aluminum Hi-Rise	
Block	Cast Iron (2 Bolt Main Bearings Caps									Cast Iron (4 Bolt Main Bearing Caps on #2, 3, 4)	
Rods	Forged Steel									Forged Steel	
Pistons	Cast Aluminum									Forged Aluminum	
Crankshaft	Cast Iron									Forged Steel	



Firing Order
1-8-4-3-6-5-7-2

Left-Hand (Standard) Rotation Engine



Firing Order
1-2-7-5-6-3-4-8

Right-Hand (Opposite) Rotation Engine

Engine	305 CID	350 CID	350 CID Production Performance

Cylinder Bore:

Diameter			3.7350 - 3.7385 (94.8690 - 94.9579)	3.9995 - 4.0025 (101.5873 - 101.6635)
Out of Round	Production		.001 (.025) Max.	
	Service		.002 (.05) Max.	
Taper	Production	Thrust Side	.0005 (.0127) Max.	
		Relief Side	.001 (.025) Max.	
	Service		.001 (.025) Max.	

Piston:

Clearance	Production	.0007 - .0017 (0.178 - .0432)
	Service	.0027 (.07) Max.

Piston Ring:

Compression	Groove Side Clearance	Production	Top	.0012 - .0032 (.0305 - .0813)
			2nd	.0012 - .0032 (.0305 - .0813)
		Service		Hi Limit Production + .001 (.025)
	Gap	Production	Top	.010 - .020 (.25 - .5)
			2nd	.010 - .025 (.25 - .6)
		Service		Hi Limit Production + .010 (.25)
Oil	Groove Side Clearance	Production		.002 - .007 (.05 - .15)
		Service		Hi Limit Production + .001 (.02)
	Gap	Production		.015 - .055 (.35 - 1.35)
		Service		Hi Limit Production + .010 (.25)

Piston Pin:

Diameter		.9270 - .9273 (23.5458 - 23.5534)
Clearance	Production	.00025 - .00035 (.00635 - .00889)
	Service	.001 (.02) Max.
Fit in Rod		.0008 - .0016 (.0203 - .0406) Interference

Engine	305 CID	350 CID	350 CID Production Performance

Crankshaft:

Main Journal	Diameter	No. 1	2.4484 - 2.4493 (62.1894 - 62.2122)
		No. 2, 3, 4	2.4481 - 2.4490 (62.1817 - 62.2046)
		No. 5	2.4479 - 2.4488 (62.1767 - 62.1995)
	Taper	Production	.0002 (.0051) Max.
		Service	.001 (.025) Max.
	Out of Round	Production	.0002 (.0051) Max.
		Service	.001 (.025) Max.
Main Bearing Clearance	Production	No. 1	.0008 - .0020 (.0203 - .0508)
		No. 2, 3, 4	.0011 - .0023 (.0279 - .0584)
		No. 5	.0017 - .0032 (.0432 - .0813)
	Service	No. 1	.001 - .0015 (.03)
		No. 2, 3, 4	.001 - .0025 (.03 - .06)
		No. 5	.0025 - .0035 (.07 - .08)
Crankshaft End Play			.002 - .006 (.05 - .15)
Connecting Rod Journal	Diameter		2.0988 - 2.0998 (53.3095 - 53.3349)
	Taper	Production	.0005 (.0127) Max.
		Service	.001 (.025) Max.
	Out of Round	Production	.0005 (.0127) Max.
		Service	.001 (.025) Max.
Rod Bearing Clearance		Production	.0013 - .0035 (.0330 - .0889)
		Service	.003 (.07) Max.
Rod Side Clearance			.008 - .014 (.2 - .35)
Crankshaft Runout			.0015 (.0381) Max.

Engine		305 CID	350 CID	350 CID Production Performance

Camshaft and Drive:

Lobe Lift ± .002 (.051)	Intake	.263 (6.680)	.296 (7.518)
	Exhaust	.269 (6.833)	.303 (7.696)
Duration	Intake	269°	291°
	Exhaust	283°	288°
Journal Diameter		1.8682 - 1.8692 (47.452 - 47.478)	
Journal Out-of-Round		.001 (.025) Max.	
Camshaft Runout		.002 (.051) Max.	
Timing Chain Deflection [L.H. (Standard) Rotation Engines Only]		3/8 (10) From Taut Position [3/4 (19) Total]	
Camshaft Timing Gear Runout [R.H. (Opposite) Rotation Engines Only]		.004 (.102) Max.	
Crankshaft Timing Gear Runout [R.H. (Opposite) Rotation Engines Only]		.003 (.076) Max.	
Camshaft to Crankshaft Timing Gear Backlash [R.H. (Opposite) Rotation Engines Only]		.004 - .006 (.102 - .152) New Gears .004 - .008 (.102 - .203) Used Gears	

Cylinder Head:

Gasket Surface Flatness	.003 (.07) in 6 (152) .007 (.15) Overall Maximum

Flywheel:

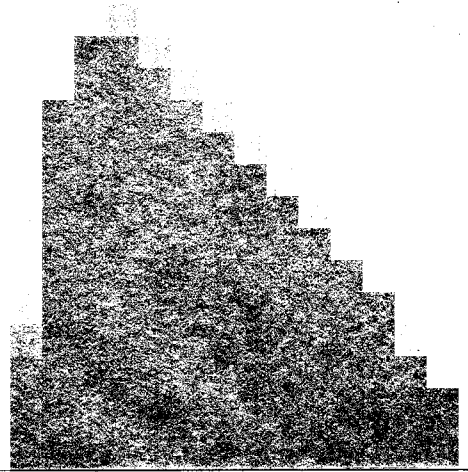
Runout	.008 (.203) Max.

Engine	305 CID	350 CID	350 CID Production Performance

Valve System:

Lifter Type			Hydraulic	
Rocker Arm Ratio			1.50 to 1	
Valve Lift	Intake		.394 (10.00)	.444 (11.28)
	Exhaust		.404 (10.26)	.454 (11.53)
Valve Lash (Intake & Exhaust)			1 Turn Down from Zero Lash	3/4 turn down from zero cash
Face Angle (Intake & Exhaust)			45°	
Seat Angle (Intake & Exhaust)			46°	
Seat Runout (Intake & Exhaust)			.002 (.051) Max.	
Seat Width	Intake		1/32 - 1/16 (.79 - 1.59)	
	Exhaust		1/16 - 3/32 (1.59 - 2.38)	
Stem Clearance	Production	Intake	.001 - .0027 (.0254 - .0686)	
		Exhaust	.001 - .0027 (.0254 - .0686)	
	Service	Intake	.0037 (.0940)	
		Exhaust	.0047 (.1194)	

NOTE 1: Conventional rocker arms, 1 turn down from zero lash;
Roller rocker arms, see page 6C-42.



Engine	305 and 350 CID	350 CID Production Performance

Valve Spring:

Valve Spring (Note 1)	Spring 24-72642 (With 2 Light Green Stripes)	Free Length		1.91 [1-29/32] (48.5)	
		Pressure (Note 2)	Closed @ 1.61 [1-39/64] (40.89)	76 - 84 Lbs. Ft. (103 - 114 N.m)	
			Open @ 1.16 [1-5/32] (29.46)	194 - 206 Lbs. Ft. (263 - 279 N.m)	
		Installed Height		1.718 [1-23/32] (43.7)	
	Spring 24-48437 (With 1 Lavender Stripe)	Free Length			2.03 [2-1/32] (51.6)
		Pressure (Note 2)		Closed @ 1.70 [1-45/64] (43.16)	76 - 84 Lbs. Ft. (103 - 114 N.m)
				Open @ 1.25 [1-1/4] (31.75)	194 - 206 Lbs. Ft. (263 - 279 N.m)
		Installed Height			1.593 [1-19/32] (40.5)
Damper	Free Length		1.86 [1-55/64] (47.24)		
	Approximate No. of Coils		4		

NOTE 1: Refer to information under "Cylinder Heads", to determine which valve spring is being used.
NOTE 2: Test spring pressure with damper removed.

General

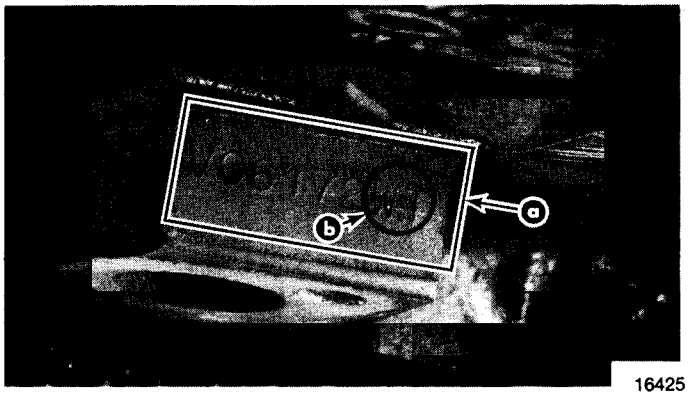
Some repairs, that are listed in this section, must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

Lubricate all moving parts (during reassembly) with engine oil. Apply Perfect Seal on threads of and under head of cylinder head bolts and on threads of all cylinder block external bolts, screws and studs.

Engine Identification

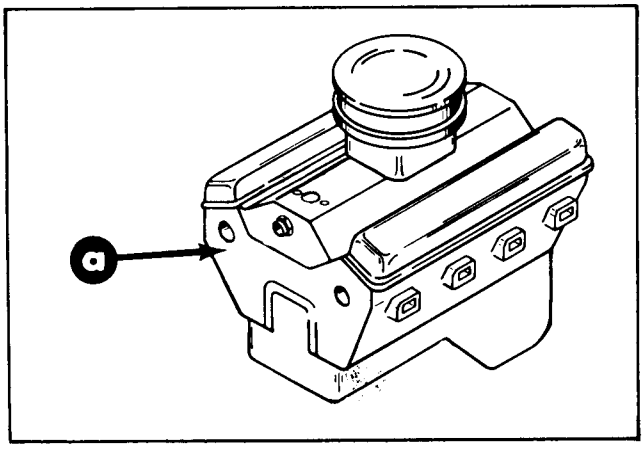
The MerCruiser Model can be determined by looking at the last two letters of the engine code stamped into the cylinder block. This code number is stamped on all MerCruiser Power Packages and replacement partial engines but not replacement cylinder block assemblies.

If the engine serial number, and or model decals are missing, the engine code letters may help in determining the engine models. Following is a list of G.M. engines and their respective code letters.



16425

a - Engine Code (V06172WT)
b - Last Two Letters (WT)



a - Small Block V-8 - Front, Starboard Side, Near Cylinder Head Mating Surfaces

MCM Stern Drive Engines (All Are L.H. Rotation)

200 - MX or PY
230 - MY or PZ
260 - WT or AN
300 - WK

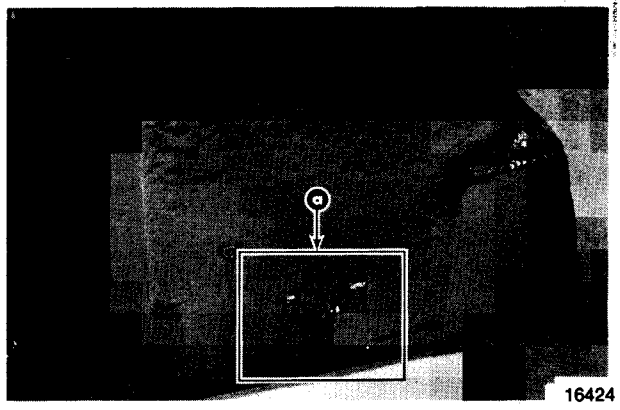
MIE Inboard Engines (Either Rotation)

L.H. Rotation
230 - MA or PA
260 - WN or AB

R.H. Rotation
230 - MB Or PB
260 - WR or AR

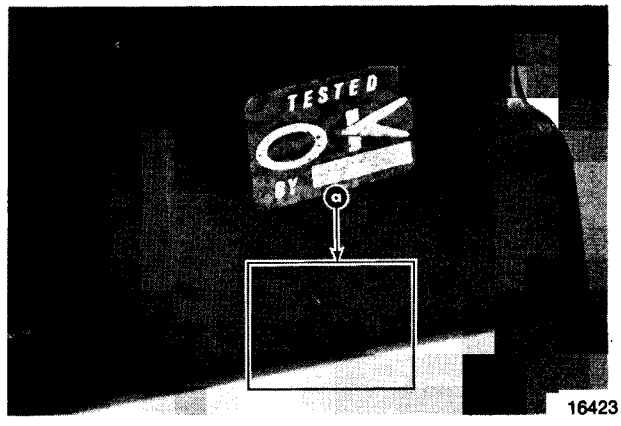
Cylinder Head Identification Marks (1980 and Newer)

The identification mark is located on both ends of the cylinder head.



16424

305 CID Engines



16423

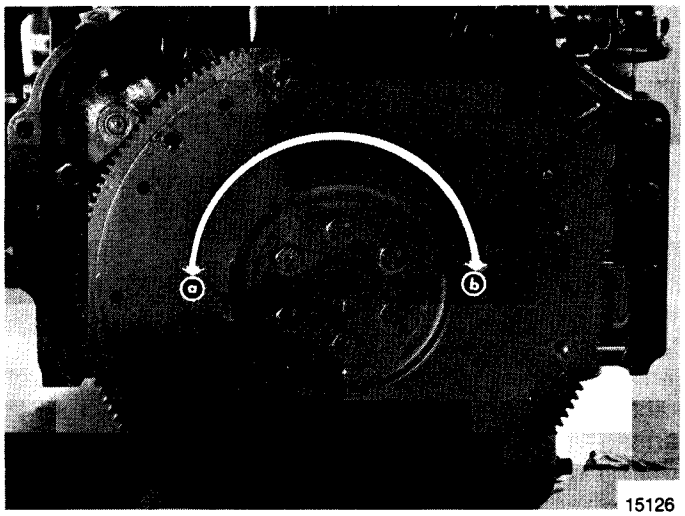
350 CID Engines

Engine Rotation

Engine rotation terminology at times has caused confusion. To clarify, engine rotation is determined by observing flywheel rotation from the rear (transmission or stern drive end) of the engine looking forward (water pump end).

PROPELLER ROTATION IS NOT NECESSARILY THE SAME as engine rotation.

When ordering replacement engines, short blocks or parts for engines, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



a - Left Hand Rotation (CCW) - All Stern Drive Engines, MIE Inboard L.H. (Standard) Rotation
b - Right Hand Rotation (CW) - MIE Inboard R.H. (Opposite) Rotation

Crankshaft

The crankshaft is supported in the block by five insert type bearings. Crankshaft end thrust is controlled by flanges on the number five bearing. A torsional damper on the forward end of the crankshaft serves to help dampen any engine torsional vibration.

Piston and Connecting Rods

Piston pins are offset slightly toward the thrust side of the pistons to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins have a floating fit in the piston and a press fit in the connecting rod (to hold them in place).

Connecting rods are made of forged steel and are connected to the crankshaft thru insert type bearings.

Camshaft and Drive

Camshaft is supported by five bearings, which are pressed into the block, and is driven at one-half crankshaft speed by a timing chain and sprockets or by timing gears.

Taper on lobes coupled with spherical foot on hydraulic valve lifters, causes the valve lifters to rotate, thus reducing wear. A helical gear on the aft end of the camshaft drives the distributor and oil pump, while an eccentric cam on the front of the camshaft actuates the fuel pump.

Cylinder Head

The cylinder heads are made of cast iron and have individual intake and exhaust ports for each cylinder.

Stainless steel or composition head gaskets are used to retard corrosion.

Valve Train

The valves and valve springs are of a heavy-duty design to withstand the high engine speeds encountered. Valve tips have been hardened to extend valve life. Exhaust valve rotators are used on some engines to help extend valve life.

Hydraulic valve lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the push rods which in turn actuate the valves thru the rocker arm.

In addition to transmitting thrust of the cam lobes, the hydraulic lifters also serves to remove any clearance (lash) from the valve train to keep all parts in constant contact.

The valve lifters also are used to lubricate the valve train bearing surfaces.

Intake Manifold

The manifold is of the double level design for efficient fuel distribution. The upper level of passages feeds cylinders 2, 3, 5 and 8 while the lower level passages feed cylinders 1, 4, 6 and 7. All passages are of approximately equal length to assure more even fuel-air mixture to the cylinders.

Lubrication System

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft, connecting rods, camshaft bearings and valve lifters, and is supplied under controlled volume to the push rods and rocker arms. All other moving parts are lubricated by gravity flow or splash.

A positive displacement gear-type oil pump is mounted on the rear main bearing cap and is driven by an extension shaft from the distributor (which is driven by the camshaft). Oil from the bottom of the pump in the rear of the oil pan is drawn into the oil pump through an oil pickup screen and pipe assembly.

If screen should become clogged, a relief valve in the screen will open and continue to allow oil to be drawn into system. Once the oil reaches the pump, the pump forces the oil thru the lubrication system. A spring loaded relief valve in the pump limits the maximum pump output pressure.

After leaving the pump, the pressurized oil flows thru a full-flow oil filter. On engines with an engine oil cooler, the oil also flows thru the cooler before returning to the block. A bypass valve allows oil to bypass the filter and oil cooler should they become restricted.

On 305 and 350 CID engines, some of the oil, after leaving the oil cooler and/or filter, is routed to the No. 5 crankshaft main bearing. The remainder of the oil is routed to the main oil gallery, which is located directly above the camshaft and runs the entire length of the block. From the main oil gallery, the oil is routed thru individual oil passages to an annular groove in each camshaft bearing bore. Some of the oil is then used to lubricate camshaft bearings. The remainder of the oil is routed to the valve lifter oil galleries and No. 1, 2, 3, and 4 crankshaft main bearings by means of individual oil passages which intersect with the annular grooves.

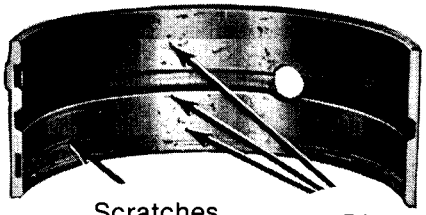
The camshaft bearings have holes which align with the oil passages or annular grooves in the block and allow oil to flow in between the bearings and the camshaft journals. The oil that is forced out the front end of the No. 1 camshaft bearing drains down onto camshaft drive and keeps it lubricated.

The oil which reaches the crankshaft main bearings is forced thru a hole in the upper half of each bearing and flows in-between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings thru grooves in the upper half of the crankshaft main bearings and oil passages in crankshaft. Oil which is forced out the ends of the connecting rod bearings and crankshaft main bearings is splashed onto the camshaft, cylinder walls, pistons and piston pins, keeping them lubricated. Oil which is forced out the front end of the No. 1 crankshaft main bearing also assists in lubricating the camshaft drive. A baffle plate, mounted on the bottom of the main bearings or in the oil pan, prevents oil thrown from the crankshaft and connecting rods from areating the oil in the oil pan.

Oil which reaches the valve lifters oil galleries is forced into each hydraulic valve lifter thru holes in the side of the lifter. From here, the oil is forced thru the metering valve in each of the lifters (which controls the volume of oil flow) and then up thru the push rods to the rocker arms. A hole in each rocker arm push rod seat allows the oil to pass thru the rocker arm and lubricate the valve train bearing surfaces. After lubricating valve train, oil drains back to the oil pan thru oil returns holes in the cylinder head and block.

The distributor shaft and gear also is lubricated by the oil flowing thru the right valve lifter oil gallery. Fuel pump push rod is lubricated by oil thrown off from the camshaft eccentric.

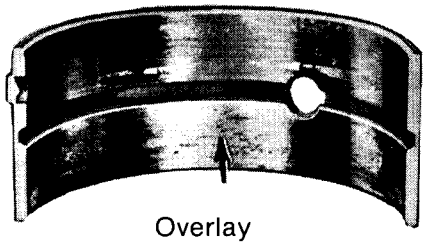
Bearing Failures



Scratches

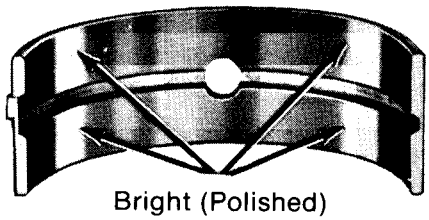
Dirt Imbedded into Bearing Material

SCRATCHED BY DIRT



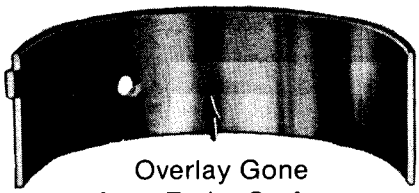
Overlay Wiped Out

LACK OF OIL



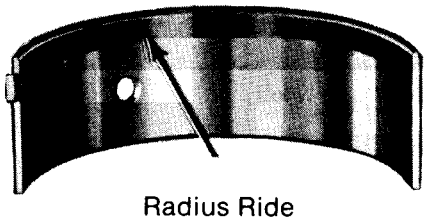
Bright (Polished) Sections

IMPROPER SEATING



Overlay Gone from Entire Surface

TAPERED JOURNAL



Radius Ride

RADIUS RIDE

Craters or Pockets

FATIGUE FAILURE

Piston Failures

Pre-Ignition

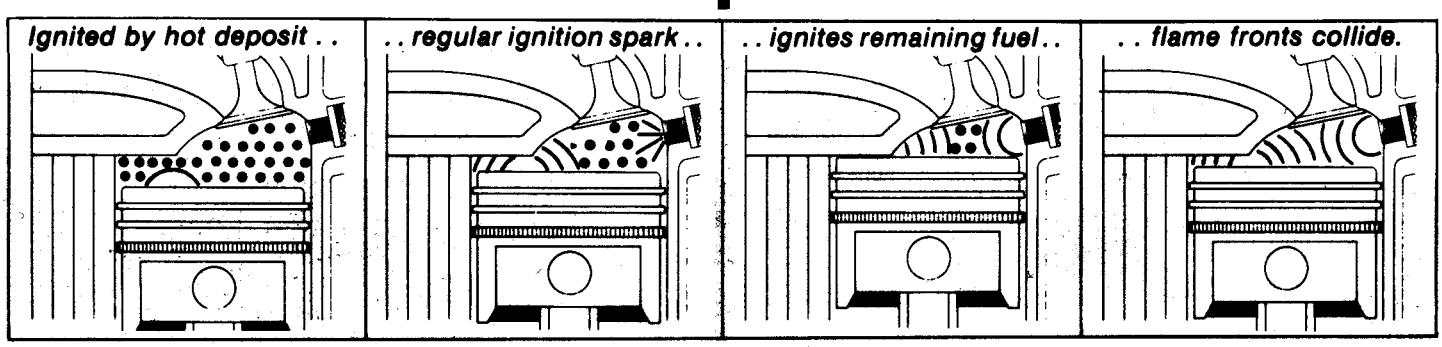
Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion of the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.

Pre-Ignition Damage

PRE-IGNITION CAUSES

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.

Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine, therefore, no warranty will apply to failures which occur under these conditions.



Detonation

Detonation, commonly called "fuel knock", "spark knock" or "carbon knock", is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.

Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

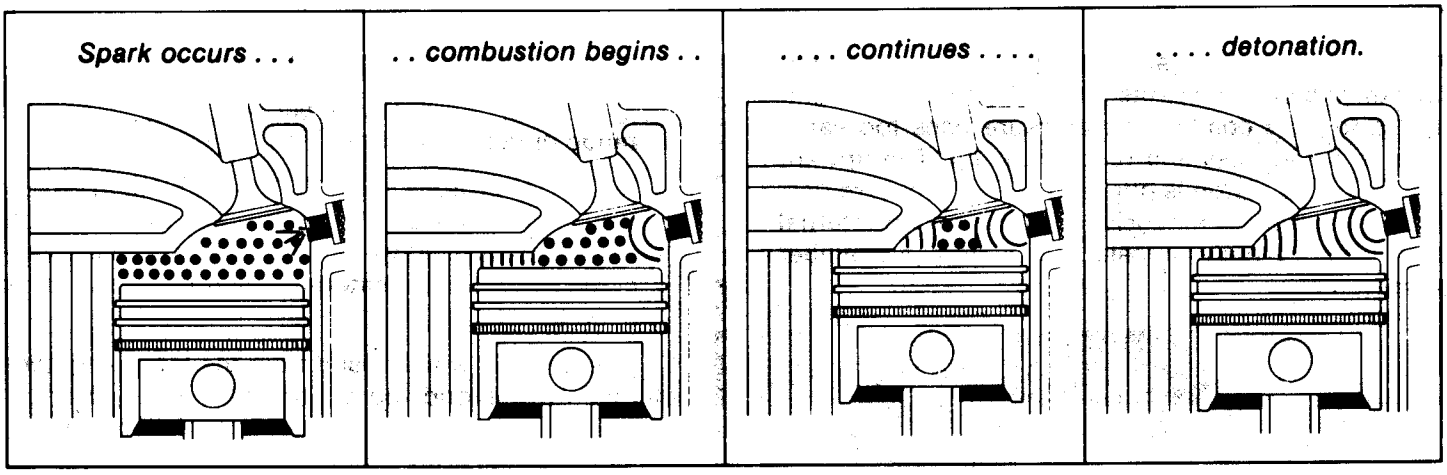
OTHER CAUSES of DETONATION

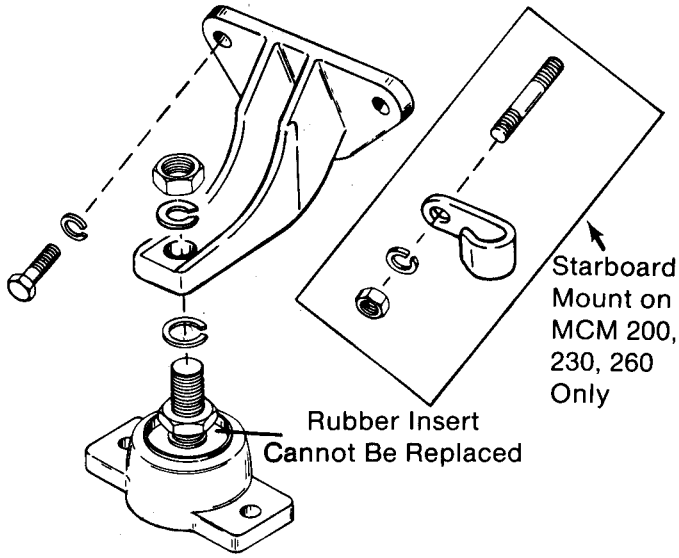
IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).
5. Inadequate cooling of engine by deterioration of cooling system.

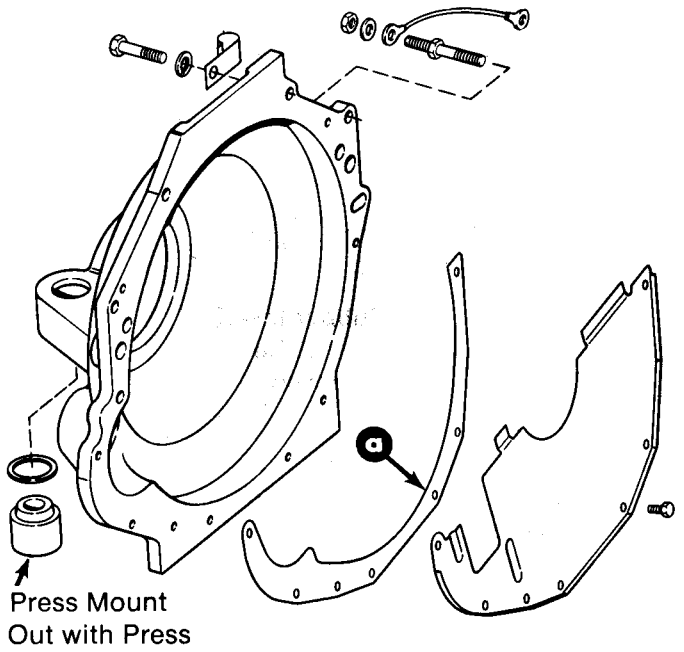
Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine, therefore, no warranty will apply to failures which occur under these conditions.

Detonation Damage



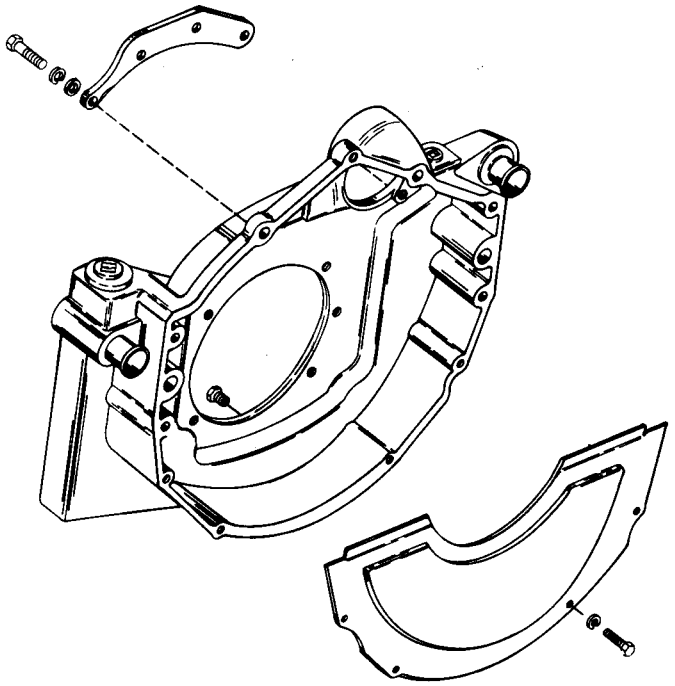


FRONT MOUNT - MCM 305/350 CID Engines

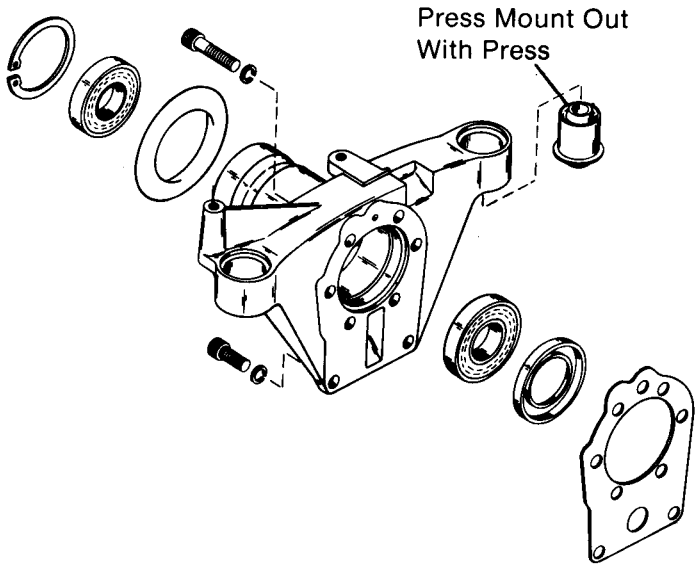


a - Gasket used on MCM Engines Only

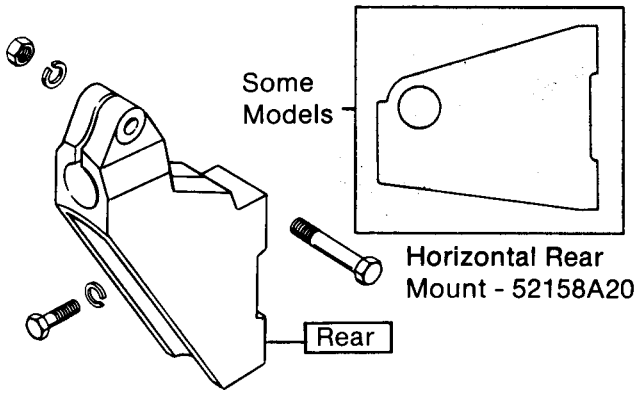
REAR MOUNT/FLYWHEEL HOUSING - MCM 305/350 CID Engines

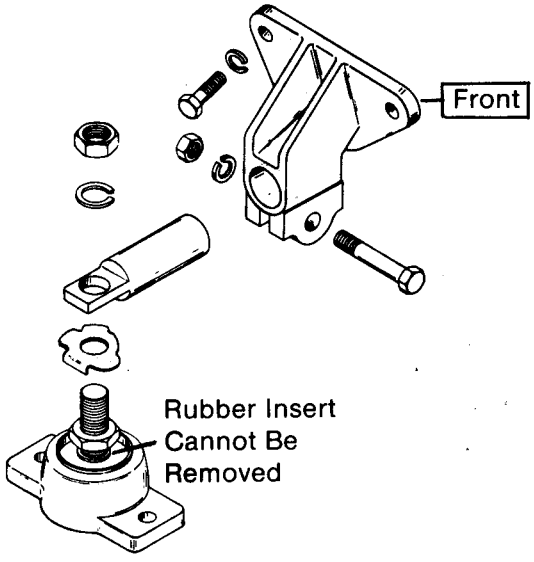


FLYWHEEL HOUSING - MCM 350 CID Production Performance

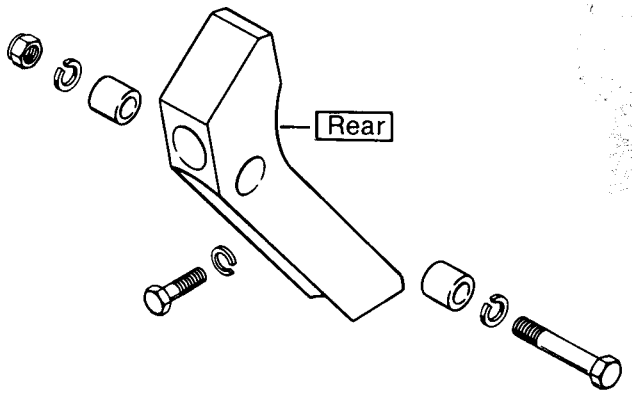


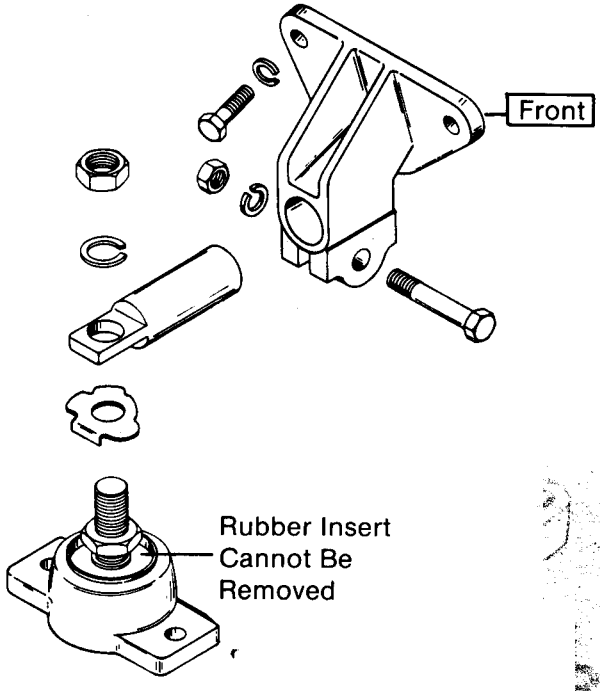
REAR MOUNT/TAILSTOCK ASSEMBLY - MCM 350 CID TRS Production Performance



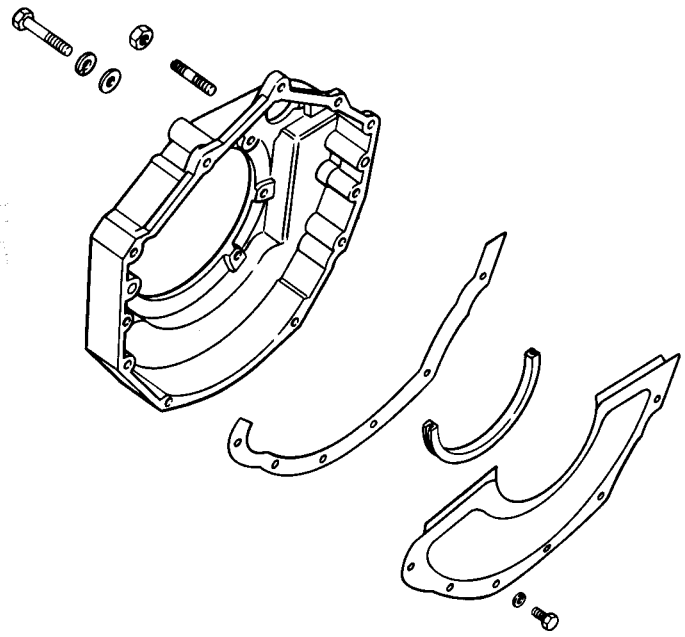


FRONT/REAR MOUNTS - MIE 305/350 CID In-Line Transmission Engines





FRONT/REAR MOUNTS - MIE 305/350 CID V-/Drive Engines



FLYWHEEL HOUSING - MIE 305/350 CID Engines

Rocker Arm Cover

Removal

On engines with Center Exhaust Outlet exhaust manifolds: It may be necessary to remove exhaust manifold before removing rocker arm cover. Also remove any component that will interfere with the removal of the manifold or rocker arm cover.

1. Remove rocker arm cover attaching hardware.
2. Disconnect crankcase ventilation hoses.

IMPORTANT: Do not pry rocker arm cover loose. Gaskets, which adhere to cylinder head and rocker arm cover, may be sheared by bumping end of rocker arm cover from the rear with palm of hand or a rubber mallet.

3. Remove rocker arm cover.

Installation

1. Clean sealing surfaces on cylinder head and rocker arm cover with degreaser.
2. Install rocker arm covers, as follows:

ROCKER ARM COVERS USING GASKETS:

a. Place new rocker arm cover gasket in position in rocker arm cover.

b. Install rocker arm cover and secure with reinforcements and attaching screws or nuts. Torque to specifications.

ROCKER ARM COVERS USING RTV SEALER:

a. Apply a 3/16" (5mm) wide bead of RTV Sealer all-the-way around sealing surface on cylinder head, making sure to apply sealer on inboard side of attaching screw holes or studs.

IMPORTANT: Be sure to install valve rocker arm cover while sealer is still wet. Sealer dries in approximately 15 minutes.

b. Install rocker arm cover and secure with attaching screws or nuts. Torque to specifications.

3. Reinstall exhaust manifolds, if removed.
4. Reinstall any items which were removed from exhaust elbows to allow removal of rocker arm covers.
5. Connect crankcase ventilation hoses to valve rocker arm covers.
6. Start engine and check for oil leaks.

Intake Manifold

Removal

1. Drain engine cooling system.
2. Disconnect hoses from thermostat housing.
3. Disconnect all electrical leads.
4. Disconnect crankcase ventilation hoses from rocker arm covers.
5. Disconnect throttle cable. Remove fuel line running between fuel pump and carburetor or fuel rails on EFI.

IMPORTANT: Do not crank engine over after distributor has been removed.

6. Remove distributor cap and mark position of rotor on distributor housing. Also, mark position of distributor housing on intake manifold. Remove distributor.
7. Remove other ignition components.
8. Remove oil sending unit.
9. Disconnect any other miscellaneous items that will prevent removal of manifold.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block, in next step. Use extreme care to prevent damage to sealing surfaces.

10. Remove intake manifold screws, then remove intake manifold.

NOTE: If intake manifold requires replacement, transfer other related parts to new manifold.

Cleaning and Inspection

1. Clean gasket material from all mating surfaces.

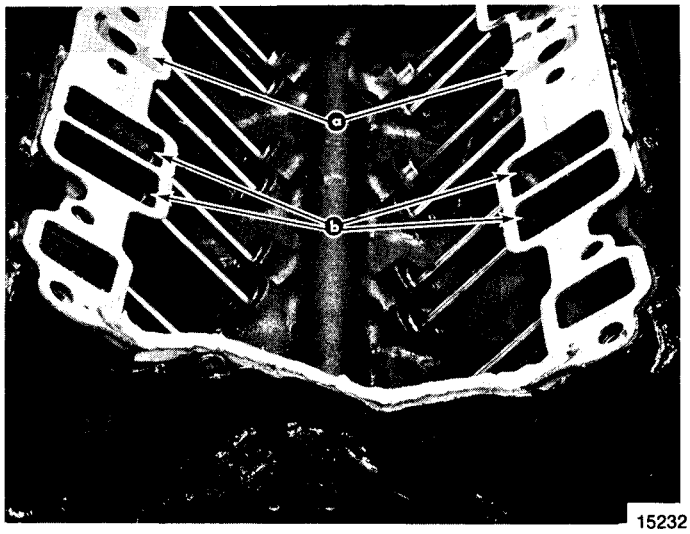
IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase.

2. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks, or deep scratches or leaks may result.
3. Check intake passages for varnish buildup or other foreign material. Clean as necessary.

Installation

IMPORTANT: When installing intake manifold gaskets, in next step, be sure to do the following:

- **Be sure to install gasket with marked side up. Both gaskets are identical.**
- **On 305 cu. in. engines with 2 barrel carburetor, remove metal insert from manifold gasket to be used on starboard (right) cylinder head to provide clearance for heat pipe on intake manifold.**
- **All MerCruiser V-8 G.M engines that have "automatic" carburetor chokes must use an intake gasket that has an opening for the exhaust crossover port in the intake manifold. Without this opening the "automatic" carburetor choke will not operate properly. The choke will remain "ON" longer causing rough engine operation and wasted fuel.**

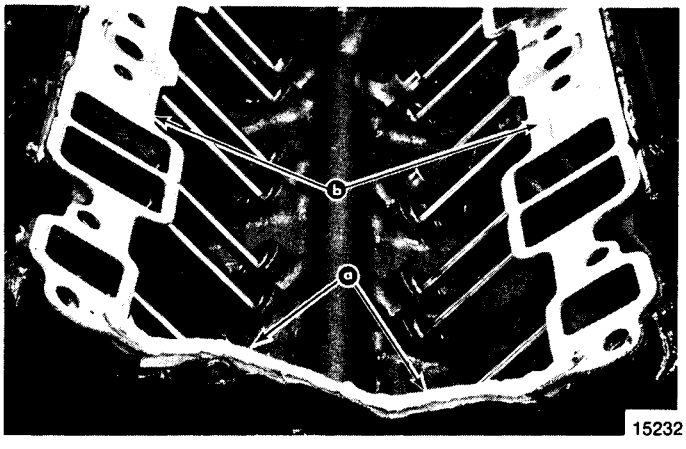


15232

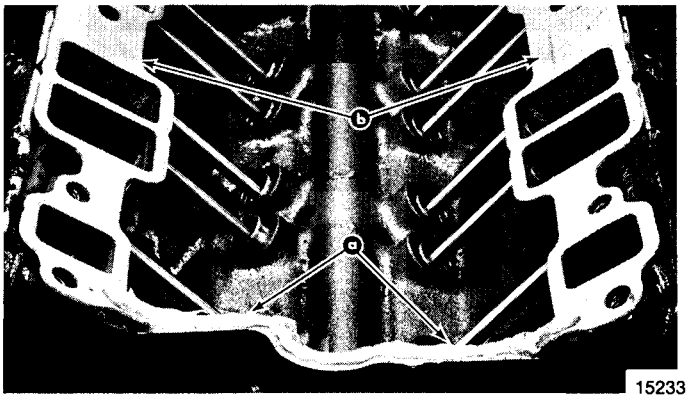
a - Exhaust Crossover Port Opening in Gasket
b - Intake Valve Ports

1. Apply Perfect Seal to intake manifold gaskets and install gaskets on cylinder heads. Install front and rear end seals on cylinder block and apply Perfect Seal to areas where seals butt against gaskets.

IMPORTANT: If cylinder block rails do not have holes for locating pins on end seals, RTV Sealer Must be used instead of seals. Place a 3/16" (5mm) wide bead of RTV Sealer. Extend the bead 1/2" (13mm) up each gasket to seal and retain gaskets. RTV Sealer can be used instead of end seals on all engines, if desired.



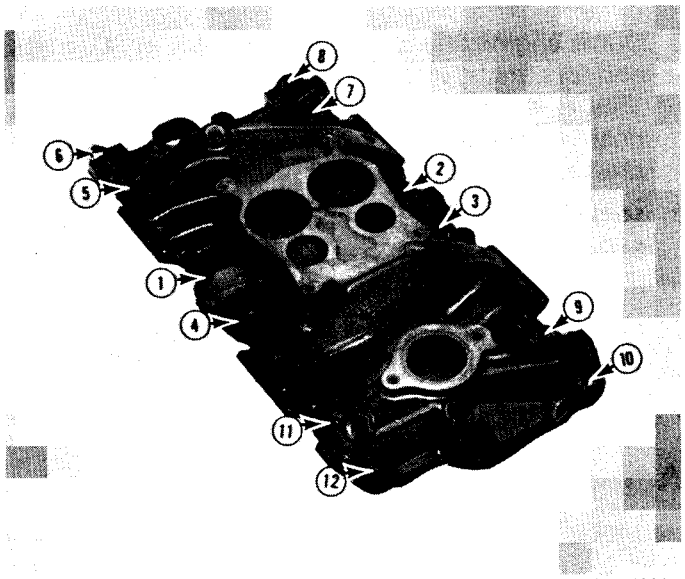
15232



15233

a - RTV Sealer
b - Intake Manifold Gaskets

2. Carefully install manifold assembly and torque bolts to specifications in sequence outlined.



14396

305/350 CID Manifold Torque Sequence Intake EFI Base Included

3. Connect all electrical leads.
4. Reconnect hoses to thermostat housing.
5. Install fuel line to carburetor, and fuel pump. Connect throttle cable fuel rails on EFI.
6. Connect crankcase ventilation hoses to rocker arm covers.
7. Install distributor. Position rotor and housing to align with marks made during removal, then install distributor cap.
8. Install other ignition components and reconnect wires.
9. Coat threads of oil pressure sending unit with Perfect Seal and install.
10. Reconnect any other items which were disconnected from manifold during the removal.
11. Start engine. Adjust ignition timing and carburetor. Check hose connections, gaskets and seals for leaks.
12. Inspect fuel line connections for fuel leaks.

Rocker Arm/Push Rod

Removal

1. Remove rocker arm covers.
2. Remove rocker arm components, rocker arms and push rods.

IMPORTANT: Place rocker arms, rocker arm components and push rods in a rack for reinstallation in the same locations.

Cleaning and Inspection

1. Clean parts with solvent and dry with compressed air.
2. Inspect all contact surfaces for wear. Replace all damaged parts.

Installation

IMPORTANT: Push rods with a hardened tip end must be installed with the hardened tip toward rocker arm. Push rods without hardened tip must be installed with large oil hole end toward rocker arms. Hardened tip end or large hole end is marked with a blue stripe.

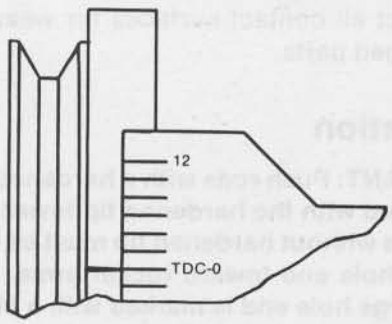
IMPORTANT: When installing rocker arms and rocker arm balls, coat bearing surfaces of rocker arms and rock arm balls with engine oil.

1. Install push rods. Be sure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts. Tighten rocker arm nuts until all lash is eliminated.
3. Valve lash can be adjusted either with engine stopped or running.

Adjustment - Engine Stopped

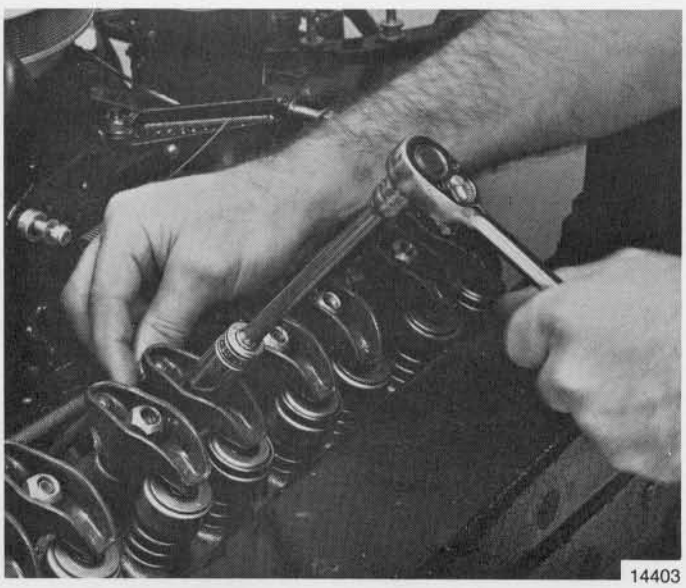
With valve cover removed, adjust valves when lifter is on low part of camshaft lobe, as follows:

1. Crank engine with starter or turn over in normal direction of rotation until mark on torsional damper lines up with center "O" mark on timing tab, and engine is in No. 1 firing position. This may be determined by placing fingers on No. 1 valve as mark on damper comes near "O" mark on timing mark. If valves move as mark comes up to timing tab, engine is in No. 6 firing position and should be turned over one more time to reach No. 1 position.
2. With engine in No. 1 firing position as determined above, the following valves may be adjusted.



3. **MCM and MIE Left Hand (Standard) Rotation Engines:**
   Exhaust - 1-3-4-8 Intake - 1-2-5-7

   MIE Right Hand (Opposite) Rotation Engines:
   Exhaust - 1-2-5-7 Intake - 1-3-4-8
4. Back out adjusting nut until lash is felt at push rod, then turn in adjusting nut until all lash is removed. This can be determined by moving push rod up-and-down while turning adjusting nut until all play is removed.

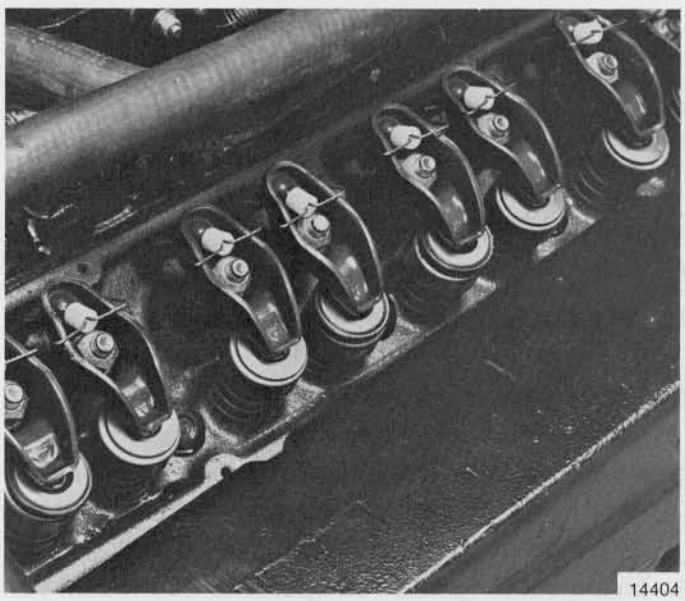

14403

Valve Adjustment

5. Hydraulic lifters now can be adjusted by tightening adjustment nut an additional 1-turn. No other adjustment is required.
6. Crank engine one revolution until pointer "O" mark and torsional damper mark are again in alignment. This is No. 6 firing position. With engine in this position, the following valves may be adjusted as previously outlined.
7. **MCM and MIE Left Hand (Standard) Rotation Engines:**
   Exhaust - 2-5-6-7 Intake - 3-4-6-8

   MIE Right Hand (Opposite) Rotation Engines:
   Exhaust - 3-4-6-8 Intake - 2-5-6-7

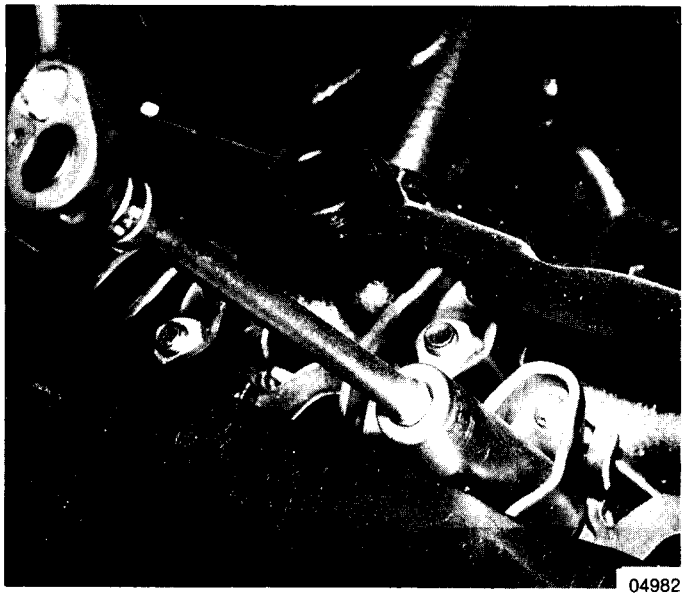
Adjustment - Engine Running


14404

Rocker Stoppers 91-66273

Following procedure is performed with engine running:

1. After engine has been rechecked for normal operating temperature, remove valve covers and install rocker stoppers.
2. With engine running at idle, back valve rocker arm nuts off (one at a time) until valve rocker arm starts to clatter.
3. Turn rocker arm nut down until clatter just stops. This is zero lash position.
4. Turn nut down 1/4 additional turn and pause 10 seconds until engine runs smoothly. Repeat until nut has been turned down 1-turn from the zero lash position. (3/4-turn from zero lash on performance production models).

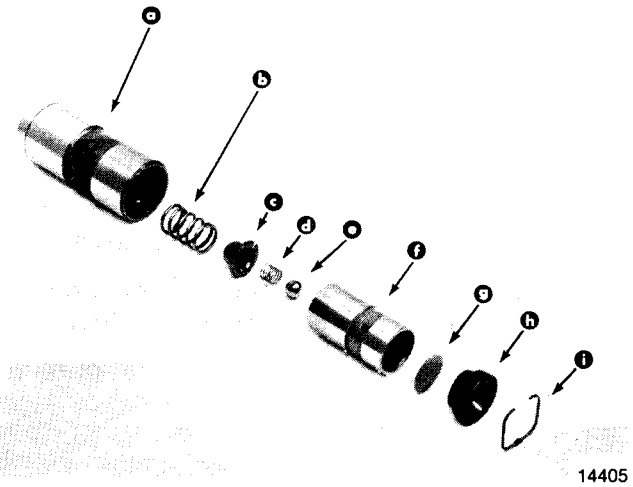


04982

IMPORTANT: This preload adjustment must be done slowly to allow lifter to adjust itself, thus preventing possibility of interference between inlet valve head and top of piston which might result in internal damage and/or bent push rods.

5. Repeat Steps 2-3-4 to adjust other valves.
6. Remove rocker stoppers after all valves are adjusted.
7. After valves have been adjusted, complete the following:
   a. Install new gaskest (or RTV), and install covers. Torque to specifications.
   b. Adjust carburetor idle speed and mixture.
   c. Start engine and check for leaks.

Hydraulic Valve Lifters



14405

a - Lifter Body
b - Plunger Spring
c - Check Ball Retainer
d - Check Ball Spring
e - Check Ball
f - Plunger
g - Metering Valve
h - Push Rod Seat
i - Push Rod Seat Retainer

Hydraulic Valve Lifter Assembly

Hydraulic valve lifters require little attention. Lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

Locating Noisy Lifters

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft. (1.2m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

1. Hard rapping noise -- Usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or "pick-up" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.

2. Moderate rapping noise -- Probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train -- This will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking -- Probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out-of-round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc, is shown to exist in one unit, it more likely exists in all the units, thus it would only be a matter of time before all lifters caused trouble.

Removal

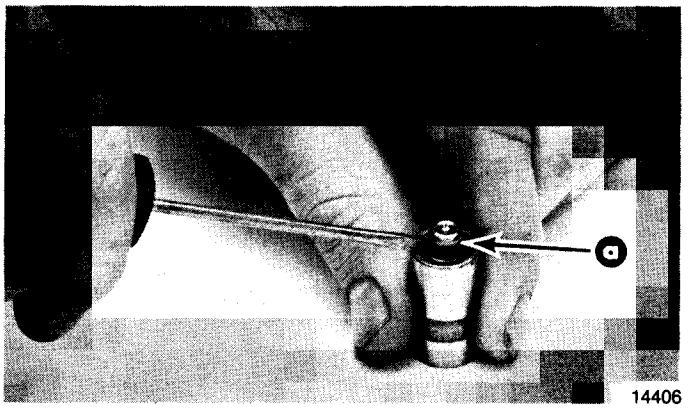
1. Remove intake manifold.
2. Remove valve mechanism.
3. Remove valve lifters.

IMPORTANT: Keep push rod and hydraulic valve lifter from each valve together as a matched set and mark them so they can be reinstalled in the same location later.

Disassembly

IMPORTANT: The internal parts of each hydraulic lifter assembly are matched sets. Do not intermix the parts.

1. Hold plunger down with a push rod and remove push rod seat retainer with the blade of a small screwdriver.
2. Remove push rod seat and metering valve.
3. Remove the plunger, ball check valve assembly and the plunger spring.
4. Remove the ball check valve and spring by prying the ball retainer loose from the plunger with the blade of a small screwdriver.



a - Check Ball Retainer

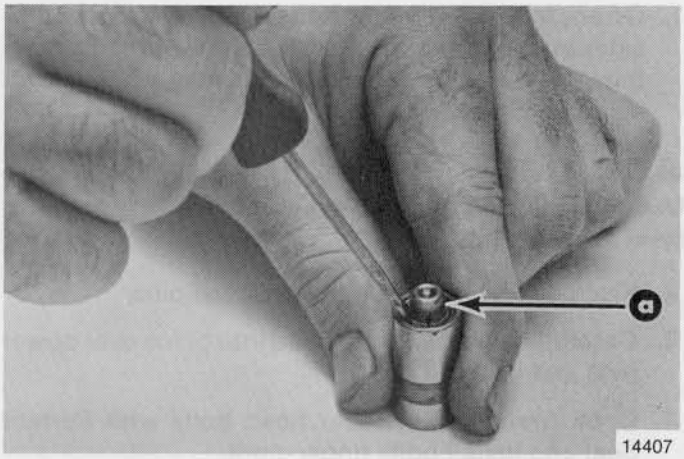
Removing Ball Check Valve

Cleaning and Inspection

Thoroughly clean all parts in cleaning solvent and inspect them carefully. If any parts are damaged or worn, entire lifter assembly should be replaced. If outer lifter body wall is scuffed or worn, inspect cylinder block lifter bore. If bottom of lifter is scuffed or worn, inspect camshaft lobe. If push rod seat is scuffed or worn, inspect push rod.

Reassembly

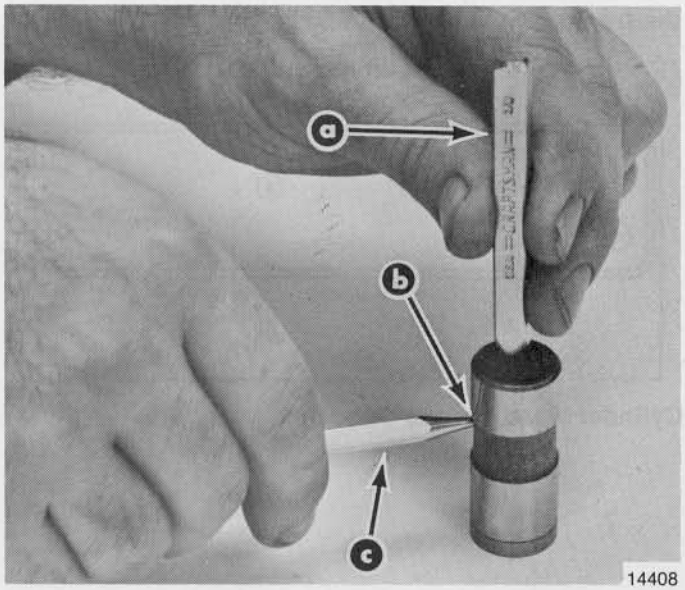
1. Place the check ball in small hole in bottom of the plunger.
2. Insert check ball spring on seat in ball retainer and place retainer over ball so that spring rests on the ball. Carefully press the retainer into position in plunger with the blade of a small screwdriver.



a - Check Ball Retainer

Installing Check Ball Valve

3. Place the plunger spring over the ball retainer and slide the lifter body over the spring and plunger, being careful to line up the oil feed hole in the lifter body and plunger.
4. Fill the assembly with oil, then insert the end of a 1/8" drift pin into the plunger and press down on check ball until hole in lifter body aligns with hole in plunger.
5. Insert a 1/16" drift pin through both oil holes to hold the plunger down against the lifter spring tension.



a - 1/8" Drift Pin
b - Oil Feed Hole
c - 1/16" Drift Pin

Oil Feed Holes Aligned and Drift Pin Installed

IMPORTANT: Do not attempt to force or pump the plunger.

6. Remove the 1/8" drift pin and refill assembly with oil.
7. Install the metering valve, push rod seat and push rod seat retainer.
8. Press down on the push rod seat with a push rod and remove 1/16" drift pin from lifter. The lifter is now completely assembled, filled with oil and ready for installation.

Installation

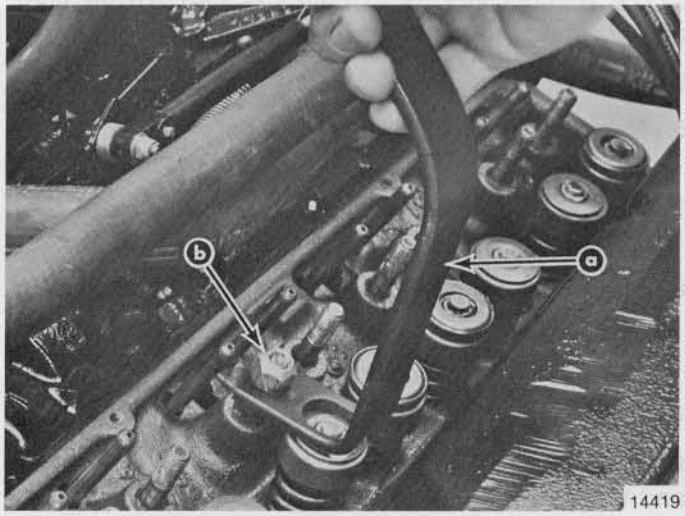
IMPORTANT: Before installing lifters, coat the bottom of the lifter with engine oil. If new lifters or a new camshaft has been installed, an additive containing EP lube should be poured over camshaft lobes before installing lifters.

1. Install hydraulic valve lifters.
2. Install intake manifold.
3. Install and adjust valve mechanism as outlined.
4. Install rocker arm cover.
5. Start engine and check for leaks.

Valve Stem Oil Seal/ Valve Spring

Removal

1. Remove rocker arm cover.
2. Remove spark plug, rocker arm and push rod on cylinder(s) to be serviced.
3. Position piston (in cylinder to be serviced) at TDC, to prevent valve from dropping out of valve guide.
4. Compress valve spring with J-5892 Tool. Remove valve locks and all other components.



a - J-5892 Tool
b - Rocker Arm Nut

Compressing Valve Spring

Installation

1. If removed, install damper in valve spring.
2. If engine has additional valve stem seal:
   a. Install intake valve seal.
   b. Do not install exhaust valve seal, discard.
3. Set valve spring, damper, valve shield and cap in place. Be sure to install valve cap with rotator on exhaust valve. Compress spring with Tool J-5892 and install oil seal into lower groove of valve stem.

NOTE: A light film of oil will help prevent twisting of the seal.

4. Install valve locks and release pressure of tool, being sure that locks are in place. Grease may be used to help hold locks while removing pressure from tool.

IMPORTANT: Compress valve spring only enough to install valve locks in next step. Excess compression could cause damage to seal.

Install spark plug(s) and torque to specifications.

Install and adjust valve mechanism.

Install rocker arm cover and torque to specifications.

Start engine and check for leaks.

Cylinder Head

Removal

1. Drain engine cooling system.
2. Remove exhaust manifolds.
3. Remove intake manifold.
4. Remove valve mechanism.

NOTE: Remove any component attached to front or aft end of cylinder head to be removed.

5. Remove spark plugs.
6. Remove spark plug wire retainers from cylinder head.
7. Remove cylinder head bolts, cylinder head and gasket.
8. Place cylinder head on 2 blocks of wood to prevent damage.

Cleaning and Inspection

For cleaning and inspection, refer to "Cylinder Head and Valve Conditioning".

Installation

⚠CAUTION

Gasket surfaces on both head and block must be clean of any foreign matter and free of nicks or deep scratches. Cylinder bolt threads in block and threads on cylinder head bolts must be clean (Dirt will affect bolt torque).

1. On engines using a stainless steel gasket, coat both sides of new gasket with Perfect Seal. Spread sealer thin and even. Too much sealer may hold gasket away from head or block.

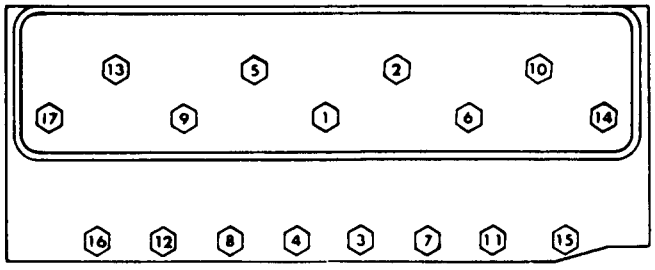
⚠CAUTION

Use no sealer on engines which have a composition steel asbestos gasket.

2. Place gasket in position over dowel pins.
3. Carefully guide cylinder head into place over dowel pins and gasket.
4. Coat threads of cylinder head bolts with Perfect Seal and install bolts finger-tight.
5. Tighten each cylinder head bolt a little at a time in sequence shown in torque sequence chart until specified torque is reached.
6. Install exhaust manifolds as outlined.
7. Install intake manifold as described.
8. Install and adjust valve mechanism as outlined.
9. Install valve covers.
10. Install spark plugs. Torque spark plugs to specifications.
11. Install spark plug wire retainers.

NOTE: Install any component that was removed from the front or aft end of cylinder head.

12. Run engine, adjust timing and check for leaks.



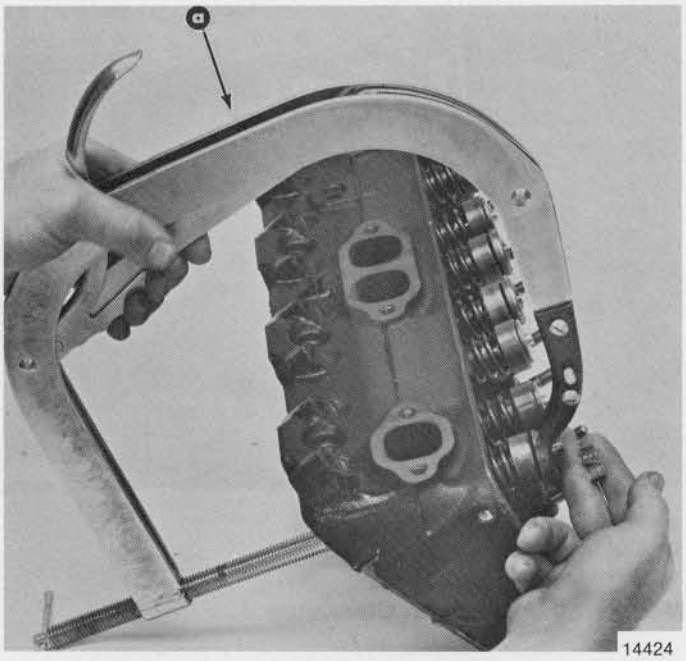
Cylinder Head Torque Sequence

Cylinder Head and Valve Conditioning

Review "Cylinder Head Assemblies" BEFORE Starting Repair.

Disassembly

1. With cylinder head removed, remove rocker arms and components (if not previously done).
2. Compress valve springs with J-8062 tool and remove valve retainers. Release compressor tool and remove all valve components.
3. Remove valves from cylinder head and place valves in a rack in their proper sequence for reassembly in their original positions.

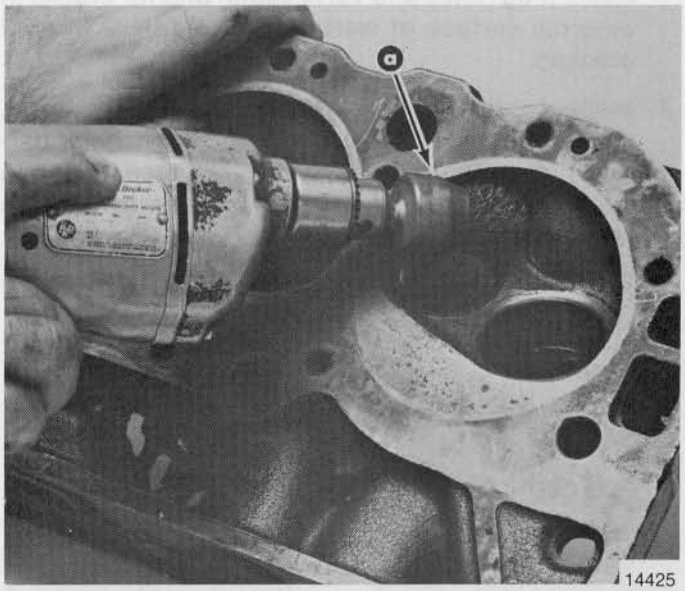


a - J-8062 Tool

Compressing Valve Spring

Cleaning

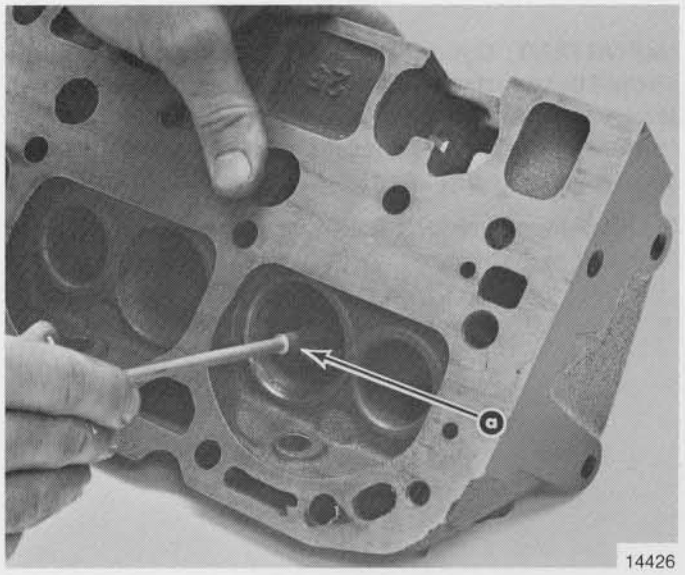
1. Clean all carbon from combustion chambers and vale ports with J-8089 tool.



a - J-8089 Tool

Cleaning Combustion Chambers

2. Thoroughly clean valve guides with J-8101 tool.
3. Clean all carbon and sludge from push rods, rocker arms and push rod guides.
4. Clean carbon from valves on a buffing wheel.
5. Clean carbon deposits and gasket material from cylinder head mating surfaces.

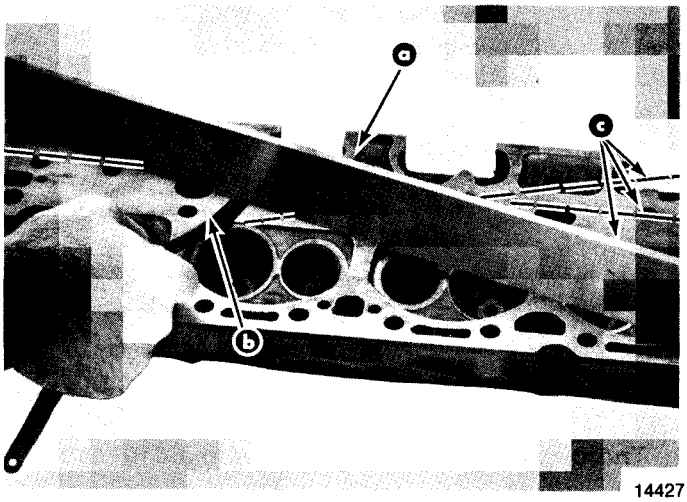


a - J-8101 Tool

Cleaning Valve Guides

Inspection

1. Inspect cylinder head for cracks in the exhaust ports, combustion chambers (especially around spark plug holes and valve seats) and for cracks in external surface of water jacket. Replace head if cracked.
2. Inspect cylinder head gasket surface for burrs, nicks, erosion or other damage. Also, check flatness of cylinder head gasket surface, using a machinists straight edge and feeler gauges as shown. Refer to "Specifications".



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a - Straight Edge
b - Feeler Gauge
c - Take Measurements Diagonally Across Head (Both Ways) and Straight Down Center Head

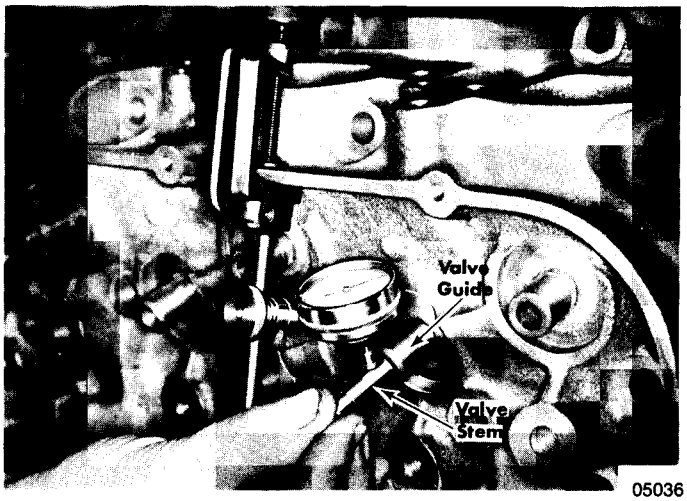
Checking Gasket Surface of Cylinder Head for Flatness

IMPORTANT: Cylinder head to block gasket surface should be resurfaced if out-of-flat more than specified. When resurfacing gasket surface, cylinder head to intake manifold gasket surface also must be milled to provide proper alignment between manifold and head.

3. Inspect valves for burned heads, cracked faces or damaged stems.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky functioning of valve and disturb engine smoothness.

4. Measure valve stem clearance as follows: Clamp a dial indicator on one side of cylinder head rocker arm cover gasket rail, locating indicator so that movement of valve stem from side-to-side (crosswise to the head) will cause a direct movement of indicator stem. Indicator stem must contact side of valve stem just above valve guide. With valve head dropped about 1/16" (2mm) off valve seat, move valve stem from side-to-side, using light pressure to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves, as outlined under "Valve Guide Bores".



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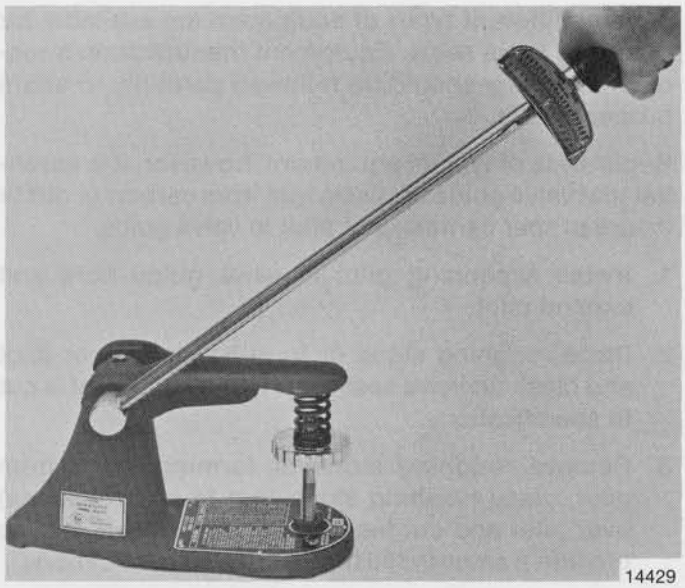
a - Valve Stem
b - Dial Indicator
c - Valve Guide

Measuring Valve Stem Clearance

5. Check valve spring tension with J-8056 spring tester.

IMPORTANT: Springs should be compressed to specified height and checked against specification. Springs should be replaced if not within 10 lbs. of specified load.

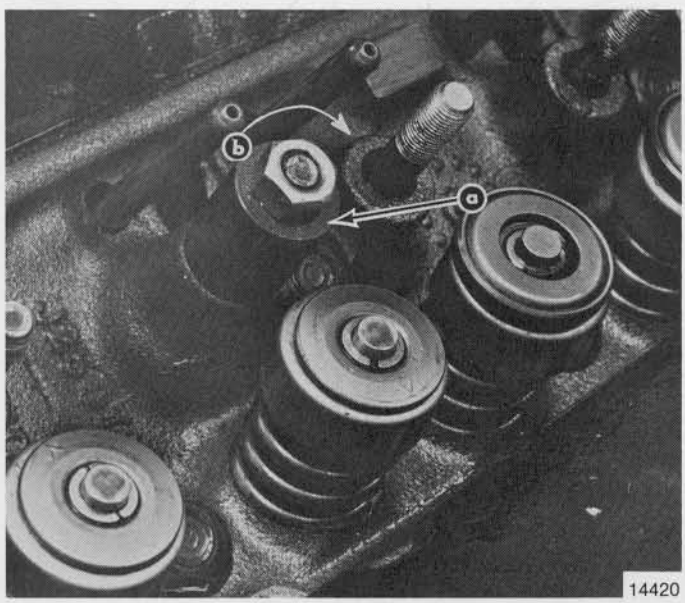
6. Inspect rocker arm studs for wear or damage. Inspect push rod guides for wear or damage.



Checking Valve Spring Tension

Rocker Arm Studs and Push Rod Guide Repairs

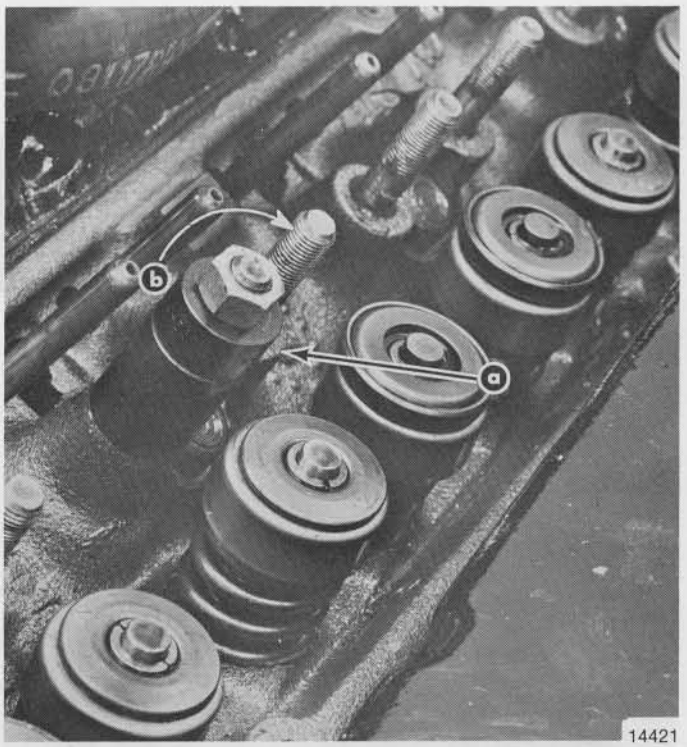
1. Rocker arm studs, which are replaced because of wear or looseness, should be replaced with oversize studs.



a - Large Sleeve
b - 3/8 x 24 Nut - Turn until Nut Bottoms Out on Stud Threads, Then Remove Nut

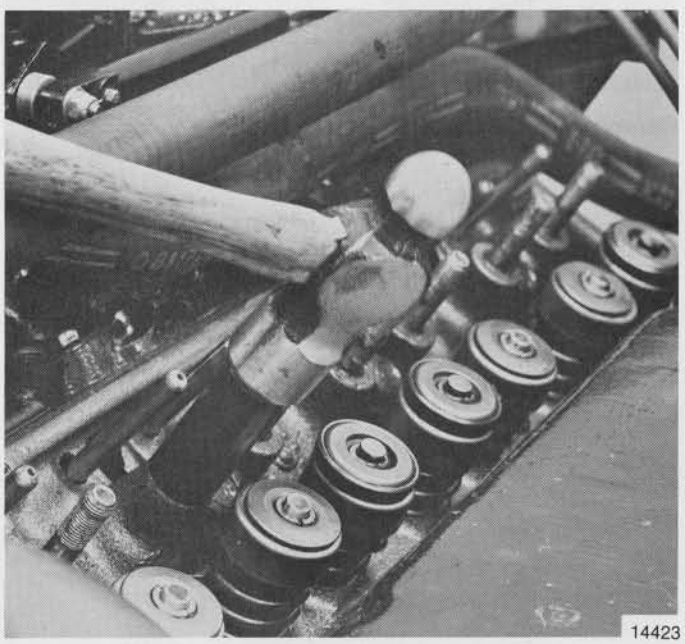
Using J-5802-01 Tool

2. Use Tool J-5802-01 to remove old stud by placing tool, flat washer and nut over stud, then turning nut.
3. Ream stud hole, whenever installing an oversize stud, using appropriate reaming tool.
4. Install new stud with Tool J-6880 or similar stud installing tool made for press-in type studs. Follow instructions with tool.



a - Install Small Sleeve
b - Turn Nut to Remove Stud

Removing Stud



Installing Stud Tool J-6880

Valve Guide Bore Repair

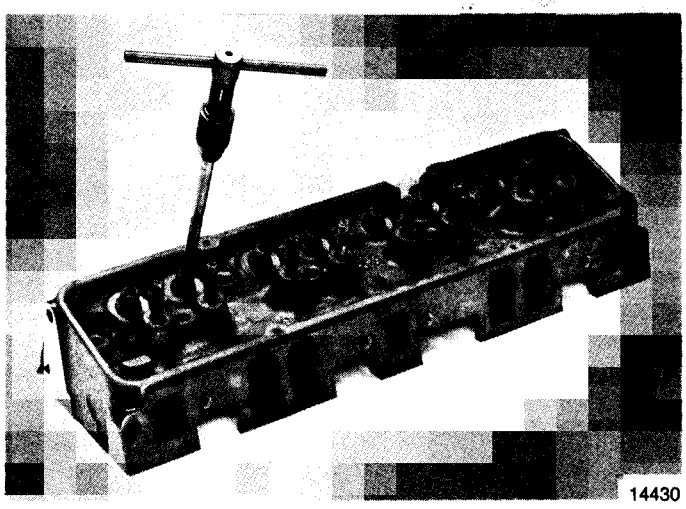
IMPORTANT: Be sure to measure valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.

If .015" oversize valves are required ream valve guide bores for oversize valves, as follows:

1. Measure valve stem diameter of old valve being replaced and select proper size Valve Guide Reamer from chart below.

Standard Valve Stem Diameter	Reamer Required for Oversize Valve
.341	J-5830-2
.372	J-7049-5

2. Ream valve guide bores, as shown.
3. Remove the sharp corner created by reamer at top of valve guide.



Reaming Valve Guides

Valve Seat Repair

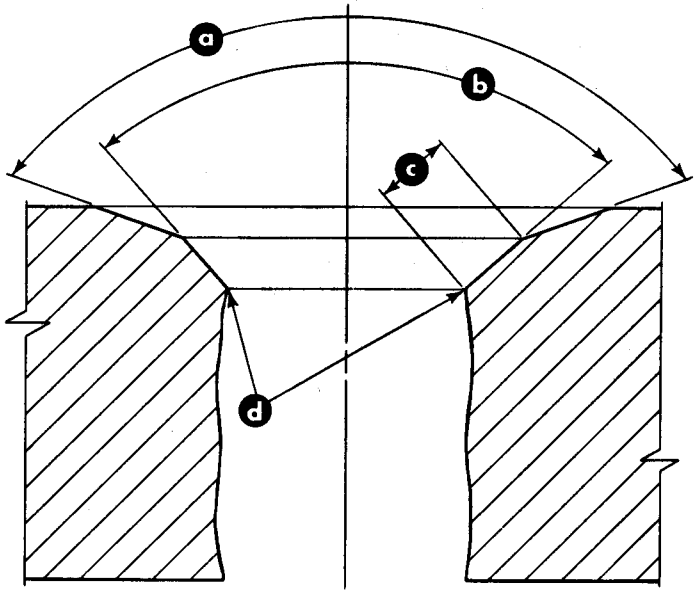
Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

Another important factor is valve head cooling. Good contact between each valve and its seat in head is important to insure that heat in valve head will be properly dispersed.

Several different types of equipment are available for reseating valve seats. Equipment manufacturer's recommendations should be followed carefully to attain proper results.

Regardless of type of equipment, however, it is essential that valve guide bores be free from carbon or dirt to insure proper centering of pilot in valve guide.

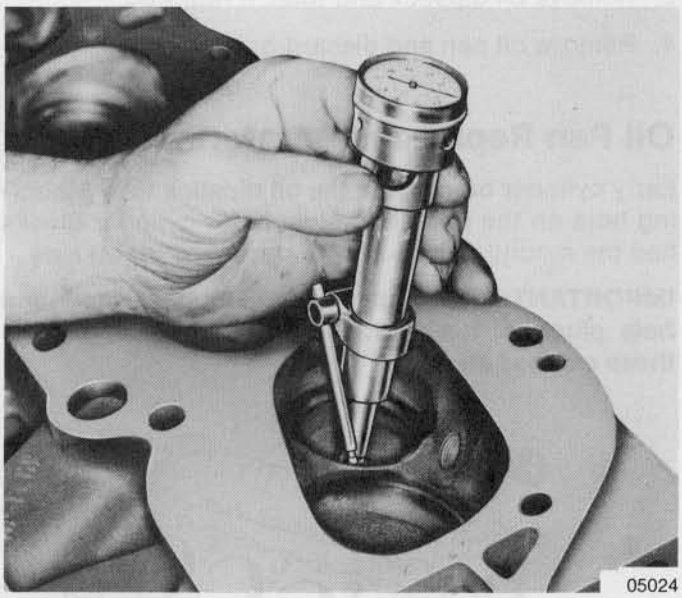
1. Install expanding pilot in valve guide bore and expand pilot.
2. Place roughing stone or forming stone over pilot and clean up valve seat only. Use a stone that is cut to specifications.
3. Remove roughing stone or forming stone from pilot, place finishing stone (cut to specifications) over pilot and cut just enough metal from seat to provide a smooth finish. Refer to "Specifications".
4. Narrow down valve seats to specified width by grinding with a 30° stone to lower seat and a 60° stone to raise seat.



a - Top Edge "Approach Angle" (30°)
b - Seat Angle
c - Seat Width
d - Bottom Edge (60°)

Valve Seat in Cylinder Head

5. Remove expanding pilot and clean cylinder head carefully to remove all chips and grindings from above operations.
6. Measure valve seat width. See "Specifications".
7. Measure valve seat "out-of-round" See 'Specifications".



Measuring Valve Seat Concentricity

Valve Repair

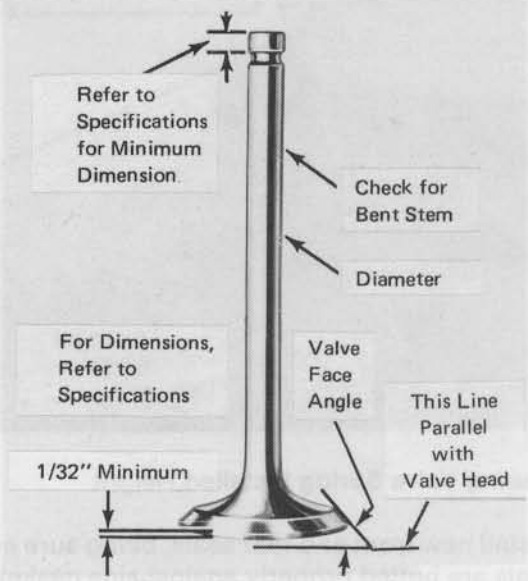
Pitted valves can be refaced to proper angle on a valve grinder, thus insuring correct relation between cylinder head seat and valve mating surface. Replace valves with excessive wear on stems or valves which are warped excessively. When an excessively-warped valve head is refaced, a knife edge will be ground on part or all of the valve head, due to amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or pre-ignition caused by heat localizing in this knife edge. If edge of valve head is less than 1/32" (.8mm) thick after grinding, replace the valve.

Various equipment is available for refacing valves. Manufacturer's recommendations should be carefully followed to attain proper results.

1. If necessary, dress the valve refacing machine grinding wheel to make sure it is smooth and true. Set chuck at angle specified for valve. Refer to "Specifications".
2. Continue grinding until valve face is true and smooth all around the valve. If this makes valve head thin [1/32" (.8mm) minimum], valve must be replaced, or valve will overheat and burn.
3. Remove valve from chuck and place stem in "V" block. Feed valve squarely against grinding wheel to grind any pit from rocker arm end of stem.

IMPORTANT: Only extreme end of valve stem is hardened to resist wear. Do not grind end of stem excessively.

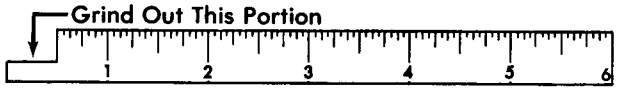
4. After cleaning valve face and cylinder head valve seat of grinding particles, make pencil marks about 1/4" (6mm) across the valve face, place valve in cylinder head and give valve 1/2-turn in each direction while exerting firm pressure on head of valve.
5. Remove valve and check face carefully. If all pencil marks have not been removed at point of contact with valve seat, repeat refacing operation and again recheck for proper seating.



Critical Valve Dimensions

Reassembly

- Lubricate valve guides and valve stems with engine oil.
- Install each valve in the port from which it was removed or to which it was fitted.
- Install valve stem oil seal, valve spring(s) and related parts on each valve as explained under "Valve Stem Oil Seal and/or Valve Spring".
- Compress valve spring with Tool J-8062.
- Check installed height of the valve springs with a narrow, thin scale. A cutaway scale will help. Measure from top of spacer (spring seat) to top of valve spring. If this exceeds specified height, install a valve spring seat shim approximately 1/16" (1.6mm) thick. At no time should spring be shimmed to give an installed height under minimum specified.



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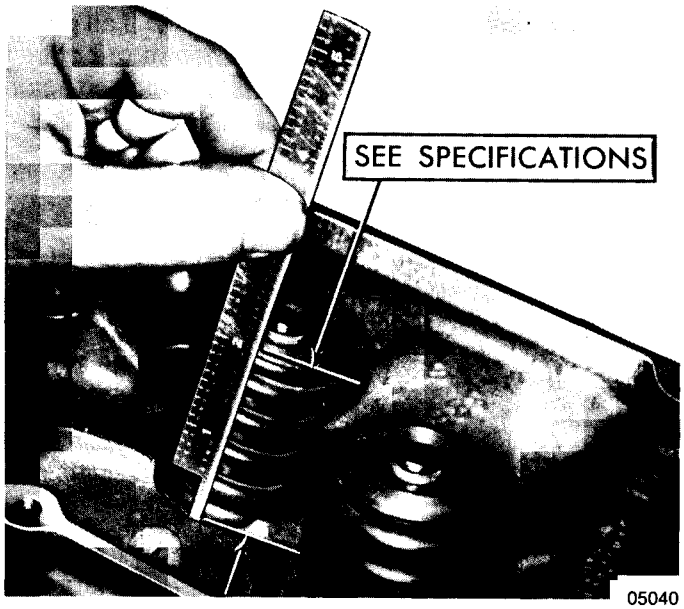
Cutaway Scale



05040

Measuring Valve Spring Installed Height

4. Install new front and rear seals, being sure ends of seals are butted properly against side gaskets.
5. Apply a 1/8" (3mm) bead of RTV Sealer to outer surface of seals. This is extremely important on inboard and V-drive engines which have aluminum oil pans.

Oil Pan

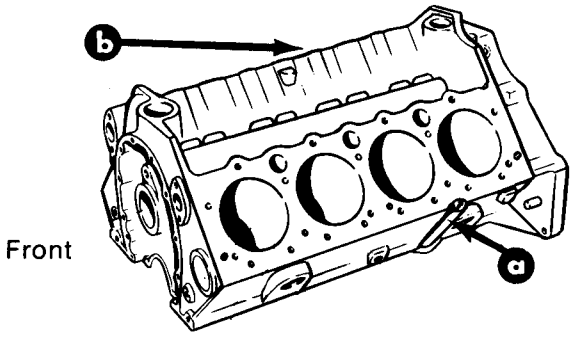
Removal

1. Drain coolant.
2. Drain crankcase oil.
3. Remove oil dipstick and tube, if required.
4. Remove oil pan and discard gaskets.

Oil Pan Replacement Information

Early cylinder blocks had the oil dipstick tube mounting hole on the port (left) side. Later cylinder blocks had the mounting hole on the starboard (right) side.

IMPORTANT: MIE engines normally have mounting hole plugged, however, this information applies to those engines also.



a - Port Side
b - Starboard Side

Oil Dipstick Tube Mounting Holes

OIL PAN BAFFLE

MCM 200 engine: Baffle is part of oil pan.

All other engines: Determine which side of engine oil dipstick tube mounting hole is on and use appropriate one. Refer to Parts Manual.

OIL PAN

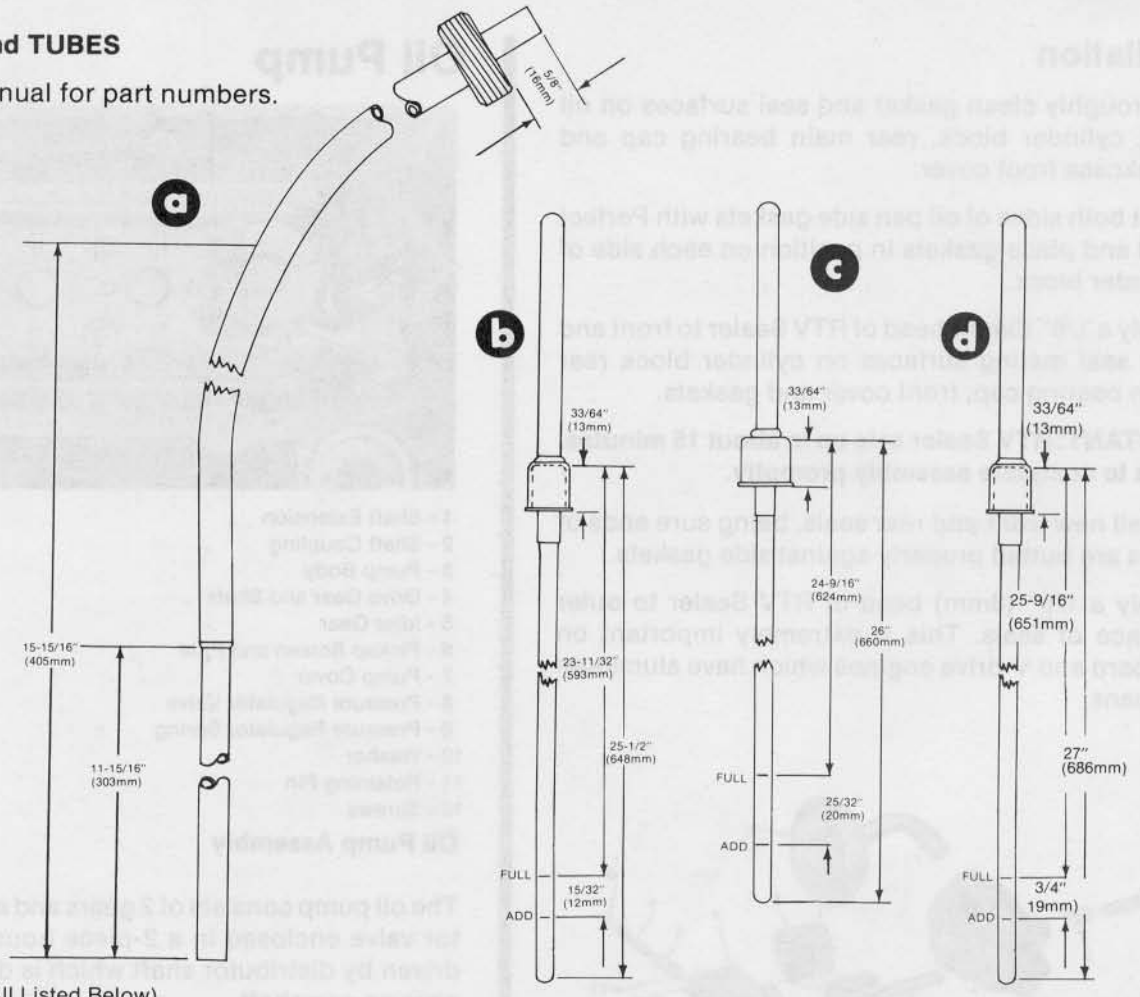
Determine which side of engine oil dipstick tube mounting hole is on and use appropriate one. Refer to Parts Manual.

OIL PAN GASKET

Determine which side of engine oil dipstick tube mounting hole is on and use appropriate one. Refer to Parts Manual.

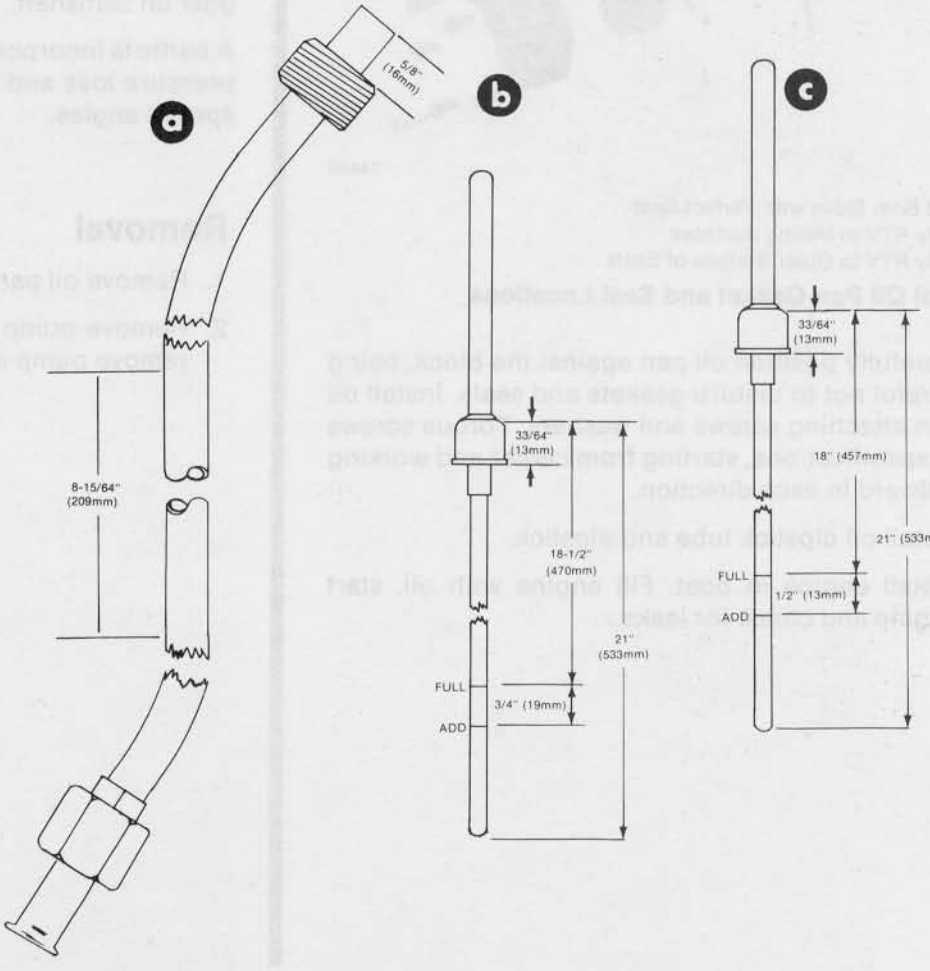
OIL DIPSTICK and TUBES

Refer to Parts Manual for part numbers.



a - 92163A2 - Tube (All Listed Below)
b - 96822A1 - Dipstick (MCM 200)
c - 96418A1 - Dipstick (MCM 230/260/300)
d - 12394 - Dipstick (MIE 5.7 Ski)

Used On: MCM 200/230/260/300
MIE 5.7 Ski



a - 86890A1 - Tube
b - 87353 - Dipstick
c - 49457 - Dipstick (MCM 230/260 V-Drive Engines and Engines That are Mounted Near Horizontal)

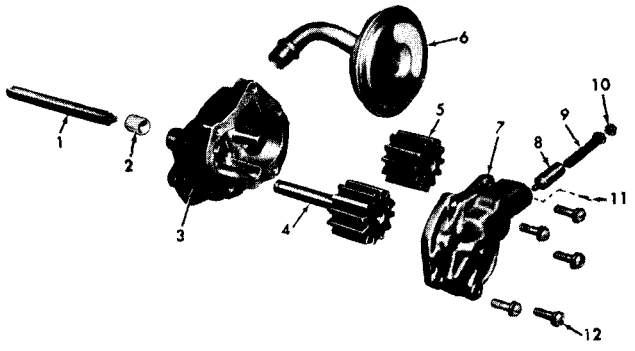
Used on: MIE 230 - All
MIE 260 - All
MIE 305 and 350 CID Engines

Installation

1. Thoroughly clean gasket and seal surfaces on oil pan, cylinder block, rear main bearing cap and crankcase front cover.
2. Coat both sides of oil pan side gaskets with Perfect Seal and place gaskets in position on each side of cylinder block.
3. Apply a 1/8" (3mm) bead of RTV Sealer to front and rear seal mating surfaces on cylinder block rear main bearing cap, front cover and gaskets.

IMPORTANT: RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

4. Install new front and rear seals, being sure ends of seals are butted properly against side gaskets.
5. Apply a 1/8" (3mm) bead of RTV Sealer to outer surface of seals. This is extremely important on inboard and V-drive engines which have aluminum oil pans.



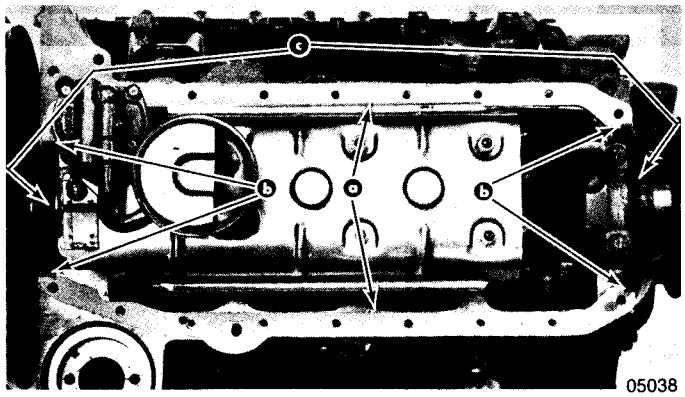
14446

a - Coat Both Sides with Perfect Seal
b - Apply RTV to Mating Surfaces
c - Apply RTV to Outer Surface of Seals

Typical Oil Pan Gasket and Seal Locations

6. Carefully position oil pan against the block, being careful not to disturb gaskets and seals. Install oil pan attaching screws and washers. Torque screws to specifications, starting from center and working outward in each direction.
7. Install oil dipstick tube and dipstick.
8. Install engine in boat. Fill engine with oil, start engine and check for leaks.

Oil Pump



05038

1 - Shaft Extension
2 - Shaft Coupling
3 - Pump Body
4 - Drive Gear and Shaft
5 - Idler Gear
6 - Pickup Screen and Pipe
7 - Pump Cover
8 - Pressure Regulator Valve
9 - Pressure Regulator Spring
10 - Washer
11 - Retaining Pin
12 - Screws

Oil Pump Assembly

The oil pump consists of 2 gears and a pressure regulator valve enclosed in a 2-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft.

A baffle is incorporated on pickup screen to eliminate pressure loss and engine oil pump tubes are bent at special angles.

Removal

1. Remove oil pan.
2. Remove pump to rear main bearing cap bolt and remove pump and extension shaft.

Disassembly

1. Remove pump cover attaching screws and pump cover.

IMPORTANT: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear, drive gear and shaft from pump body.
3. Remove retaining pin, pressure regulator valve and related parts.

IMPORTANT: Do not remove pickup screen and pipe assembly, unless replacement is necessary. Loss of press fit condition could result in an air leak and loss of oil pressure.

IMPORTANT: Do not disturb pickup screen on pipe. This is serviced as an assembly.

4. If pickup screen and pipe assembly requires replacement, mount pump in a soft jawed vise and extract pipe from pump.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage or excessive wear.
4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen or pipe.
7. Check pressure regulator valve for fit.

IMPORTANT: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.

Reassembly

⚠CAUTION

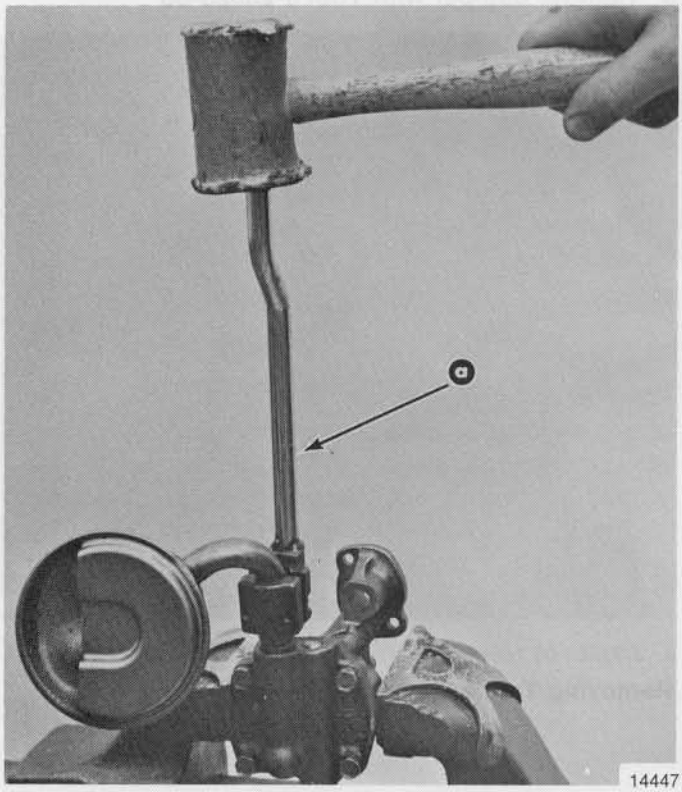
Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to oil pan rails when oil pump is installed.

If pickup screen and pipe assembly was removed, mount pump in a soft-jawed vise, apply Perfect Seal to end of new pipe and using Tool (J-8369), tap the pipe in place with a hammer.

NOTE: Tool will have to be modified to fit later engines.

IMPORTANT: Oil internal parts liberally before installation.

1. Install pressure regulator valve and related parts.
2. Install drive gear and shaft in pump body.
3. Install idler gear in pump body with smooth side of gear toward pump cover opening. Align marks made in disassembly.
4. Install pump cover and torque attaching screws to specifications.
5. Turn drive shaft by hand to check for smooth operation.



a - J-8369 Tool

Installing New Pickup Screen and Pipe Assembly

Installation

1. Assemble pump and extension shaft to rear main bearing aligning slot on top end of extension shaft with drive tang on lower end of distributor drive shaft.
2. Install pump to rear main bearing cap and torque to specifications.

IMPORTANT: Oil pump screen is installed with bottom edge parallel to oil pan rails.

3. Install oil pan as outlined.

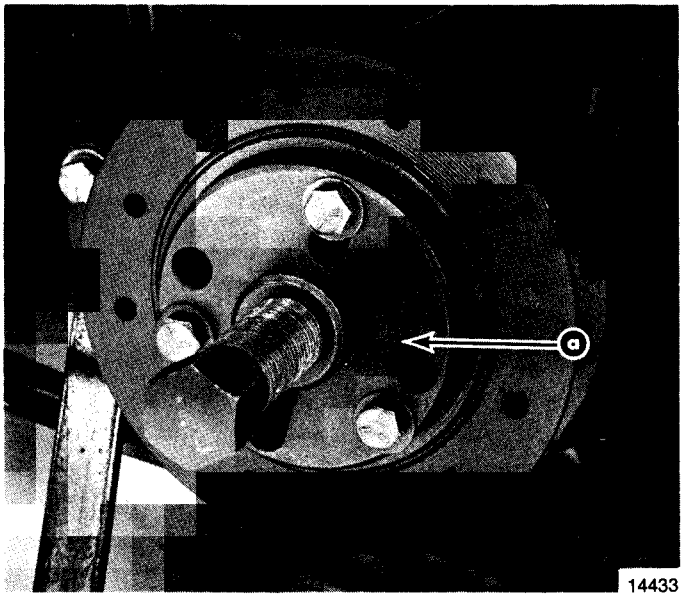
Torsional Damper

Removal

1. Remove drive belts.
2. Remove drive pulley, then remove damper retaining bolt.

IMPORTANT: Do not use a universal claw type puller to remove torsional damper (in next step) as outside ring of damper is bonded in rubber to the hub and use of claw type puller may break the bond.

3. Remove damper with Tool J-23523-03.



a - J-23523-03 Tool

Removing Torsional Damper

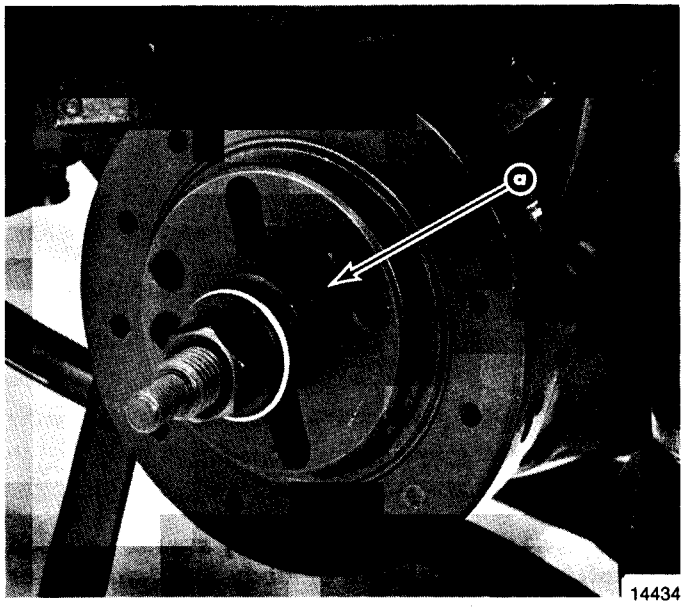
Installation

IMPORTANT: The inertia weight section of torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Coat front cover seal contact area (on damper) with engine oil.
2. Pull damper onto crankshaft, using Tool J-23523, as follows:
   a. Install appropriate end of threaded rod into crankshaft.

IMPORTANT: Be sure to install threaded rod in crankshaft so that at least 1/2" (13mm) of thread engagement is obtained to prevent damage to threads.

   b. Install plate, thrust bearing, washer and nut on rod.
   c. Pull damper onto crankshaft (by turning nut) until it bottoms-out.



a - J-23523-03 Tool

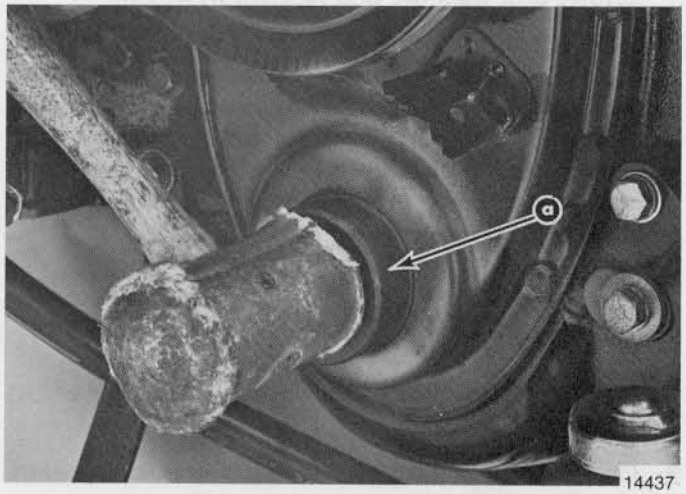
Installing Torsional Damper

   d. Remove tool from crankshaft, then, install damper retaining bolt and torque to specifications.
3. Install drive pulley(s).
4. Install and adjust drive belts.

Crankcase Front Cover/Oil Seal

Oil Seal Replacement (Without Removing Front Cover)

1. Remove torsional damper.
2. Pry seal out of cover from the front with a large screwdriver, being careful not to distort front cover or damage crankshaft seal surface.
3. Install new seal with open end of seal inward, using Tool J-23042 on 305 and 350 CID engines. Drive seal in until it just bottoms out. Do not use excessive force.
4. Reinstall torsional damper.



a - J-23042 Tool

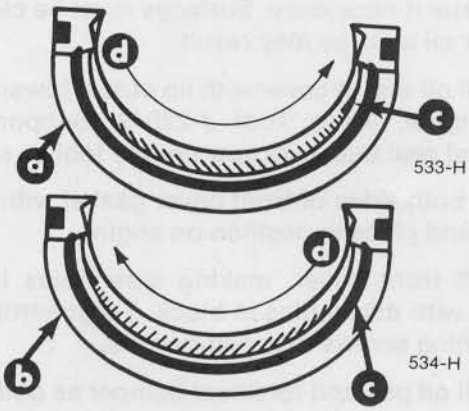
305 and 350 CID Engines

Removal

1. Remove engine from boat.
2. Remove torsional damper and oil pan.
3. Remove water circulating pump.
4. Remove crankcase front cover attaching screws and remove cover. Remove and discard cover gasket.
5. If damaged, drive oil seal out of front cover (from the rear) with a punch.

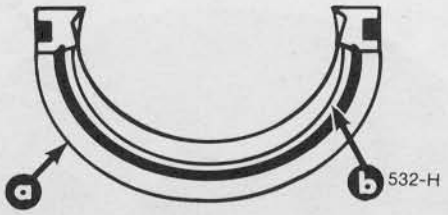
Installation

IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



a - MCM and MIE (L.H.) Rotation Engines
b - MIE (R.H.) Rotation Engines
c - Seal Lip Toward Inside of Engine
d - Rotation of Crankshaft as Viewed From Flywheel End Looking Forward

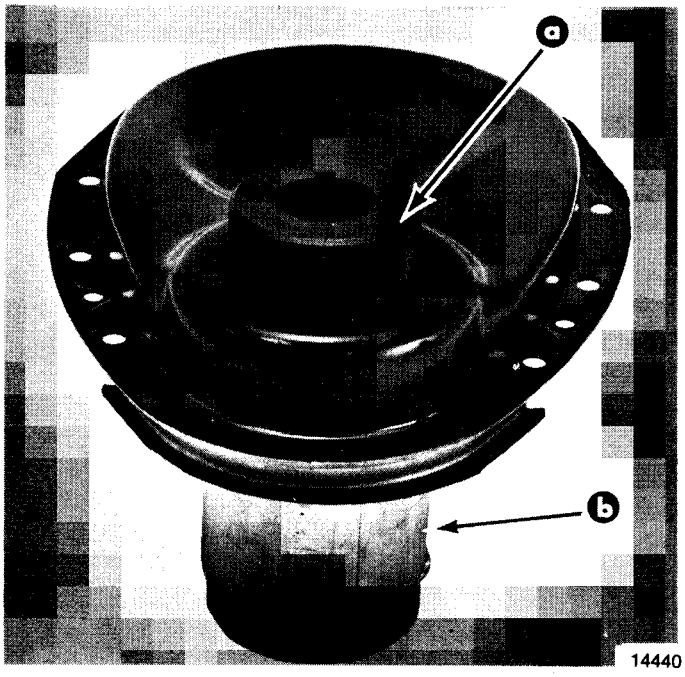
Front Seals WITH Helical Grooves



a - Can Be Used On Any Rotation Engine
b - Seal Lip Toward Inside of Engine

Front Seal WITHOUT Helical Grooves

1. Clean front cover in solvent and dry with compressed air. Clean old gasket material and sealer from mating surfaces on cover and cylinder block. Check gasket surface on front cover for distortion and true if necessary. Surfaces must be clean and flat or oil leakage may result.
2. Install oil seal in cover with lip of seal toward inside of engine, using Tool J-23042. Support cover around seal area with appropriate tool as shown.
3. Coat both sides of front cover gasket with Perfect Seal and place in position on engine.
4. Install front cover, making sure holes in cover align with dowel pins in block. Torque front cover attaching screws to specifications.
5. Install oil pan and torsional damper as outlined.
6. Install water circulating pump.
7. Reinstall engine in boat.
8. Fill crankcase with engine oil.
9. Start engine and check for water and oil leaks.

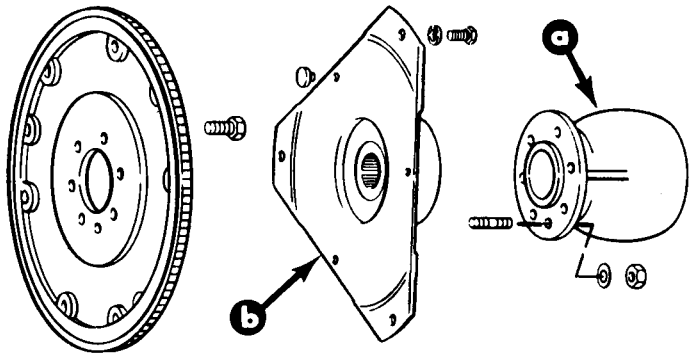


a - J-23042 Tool
b - Support (To Prevent Distorting Cover)

Flywheel

Removal

1. Remove engine from boat.
2. Remove transmission, if so equipped.
3. Remove flywheel housing and related parts, if applicable.
4. **On I-Drive Engines:** Remove flywheel and coupler attaching hardware and remove coupler and flywheel.



a - Old Style (Flywheel Stud Mounted)
b - New Style

Alpha One Couplers

5. **On Engines with Borg-Warner Transmission:** Remove drive plate attaching screws and washers and remove drive plate, then remove flywheel attaching screws and washers and remove flywheel.

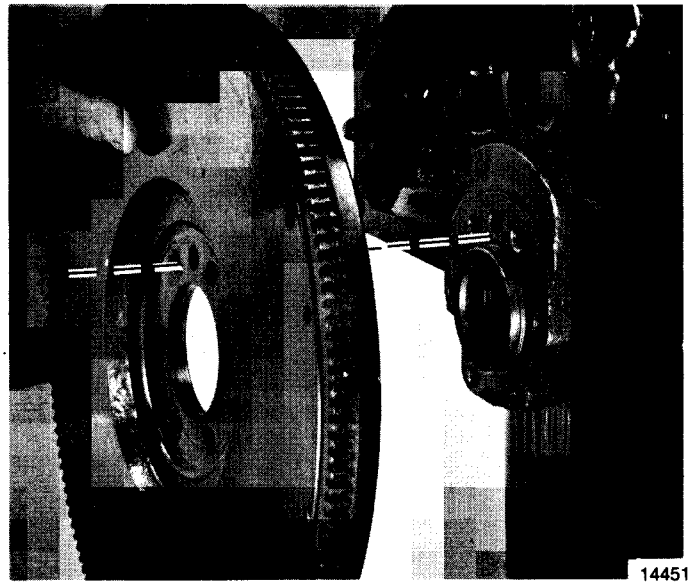
IMPORTANT: If crankshaft is to be replaced, but old pilot bushing is to be reused, bushing can be removed without damage by filling pilot bushing cavity with grease, then, inserting an old transmission input shaft in bore of bushing and hitting it with a hammer. This will create hydraulic pressure in pilot bushing cavity which should force bushing out.

Inspection

1. Inspect drive plate for wear, on engines so equipped.
2. Check flywheel ring gear for worn or missing teeth.
3. Inspect engine coupler, on engines so equipped.

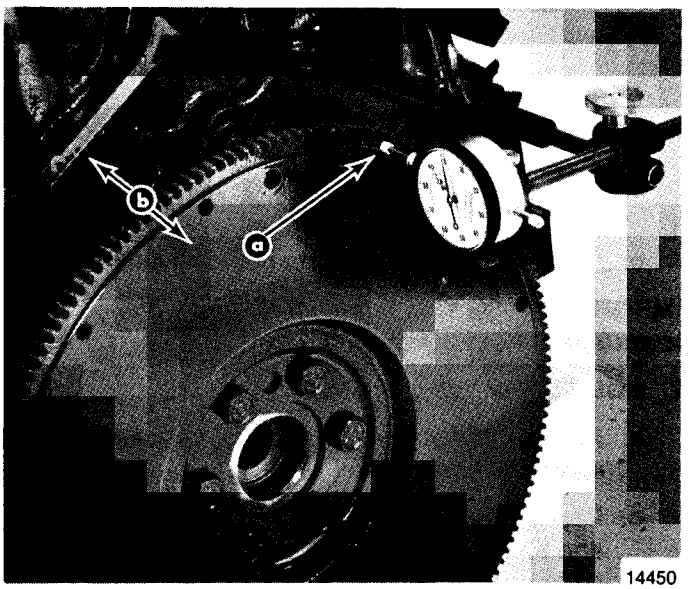
Installation

1. Clean mating surfaces of flywheel and crankshaft.



305 and 350 CID Engines

2. **On I-Drive Engines:**
   a. If removed, apply Loctite 35 to threads of studs and install in crankshaft.
   b. Align dowel hole in flywheel with dowel hole or dowel in crankshaft flange and place flywheel in position on flange.
   c. Install coupler and secure it and flywheel with washers and elastic stop nuts. Torque nuts to specifications.
3. **On Engines with Borg-Warner Transmission:**
   a. Align dowel hole in flywheel with dowel or dowel hole in crankshaft flange and place flywheel in position on flange.
   b. Secure flywheel with screws and lockwashers. Torque screws to specifications.
   c. Install drive plate and torque to specifications.
4. Check flywheel runout by mounting dial indicator on machined surface of flywheel.
5. Runout should not exceed .008" (.203mm). If excessive, remove flywheel and check for burrs or replace flywheel.



14450

a - .008" (.203mm) Max. Runout
b - Hold Flywheel and Crankshaft Forward or Rearward As Far As It Will Go When Taking Reading

Checking Flywheel Runout

6. Install flywheel housing and related parts, if so equipped. Torque flywheel housing screws to specifications.
7. Torque flywheel housing cover screws to specifications.
8. Install transmission, if so equipped.
9. Install engine in boat.

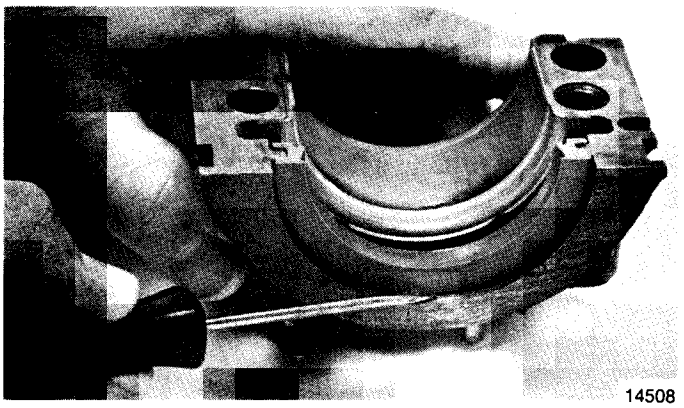
Oil Seal (Old Style Rear Main)

Replacement

Rear main bearing oil seal can be replaced (both halves) without removing crankshaft.

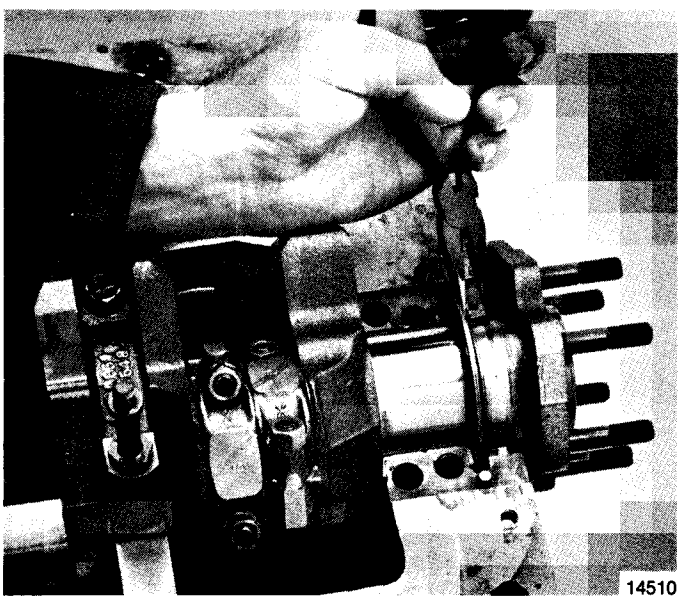
IMPORTANT: Always replace upper and lower seal as a unit. Install with lip facing toward front of engine.

1. Remove oil pan and oil pump.
2. Remove rear main bearing cap.
3. Remove lower half of oil seal from the bearing cap by prying from the bottom with a small screwdriver. Be careful not to damage seal seating surface.


14508

Removing Lower Half of Oil Seal

4. Using a hammer and a soft metal pin punch, tap upper half of oil seal on one end until it protrudes far enough on the other end to remove it with a pliers.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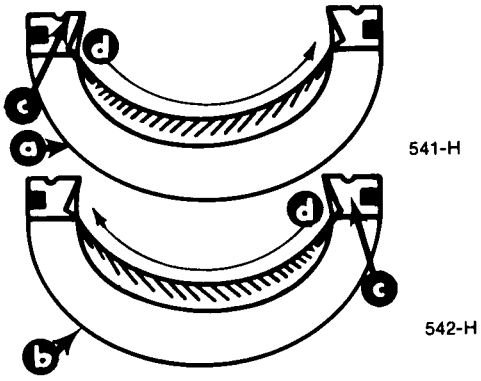
Removing Upper Half of Oil Seal

5. Clean, rear main bearing cap, cylinder block and crankshaft with solvent and blow dry with compressed air. Be sure all of the old sealer is removed from bearing cap and cylinder block mating surfaces.

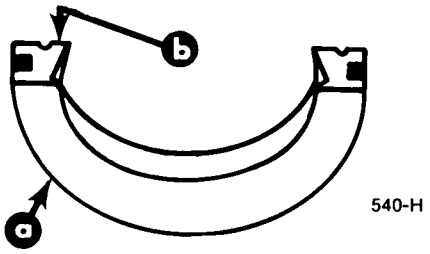
Installation

IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



a - MCM and MIE (L.H.) Rotation Engines
b - MIE (R.H.) Rotation Engines
c - Seal Lip Toward Inside of Engine
d - Rotation of Crankshaft as Viewed From Flywheel End Looking Forward

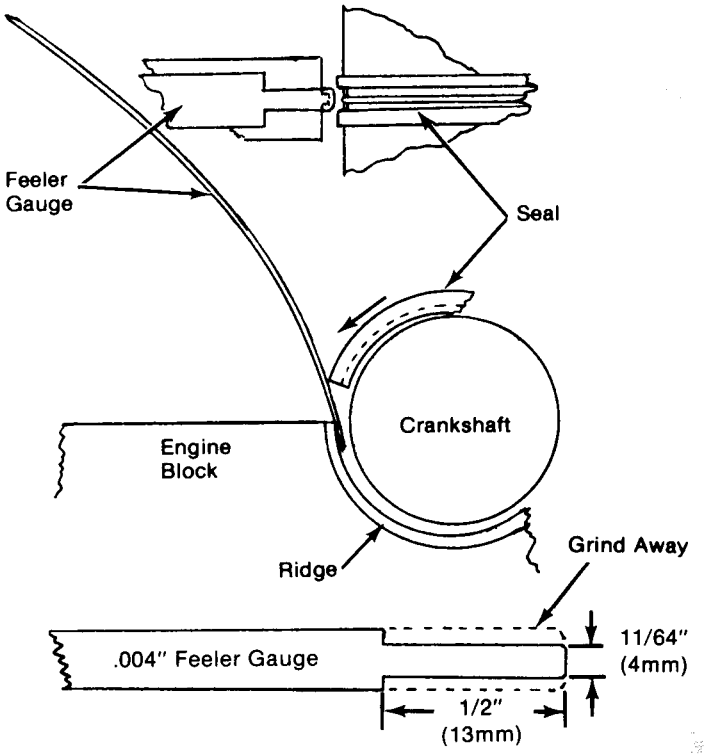
Rear Seals WITH Helical Grooves



a - Can Be Used On Any Rotation Engine
b - Sealed Lip Toward Inside of Engine

Rear Seal WITHOUT Helical Grooves

Extreme care must be exercised when installing seal to prevent damage to sealing bead, located in the channel on outside diameter of the seal. To protect this bead, installation tool must be used. Construct tool using .004" (.1mm) shim stock, if tool is not supplied with seal.



Installing Rear Main Seal - Cylinder Block Inverted

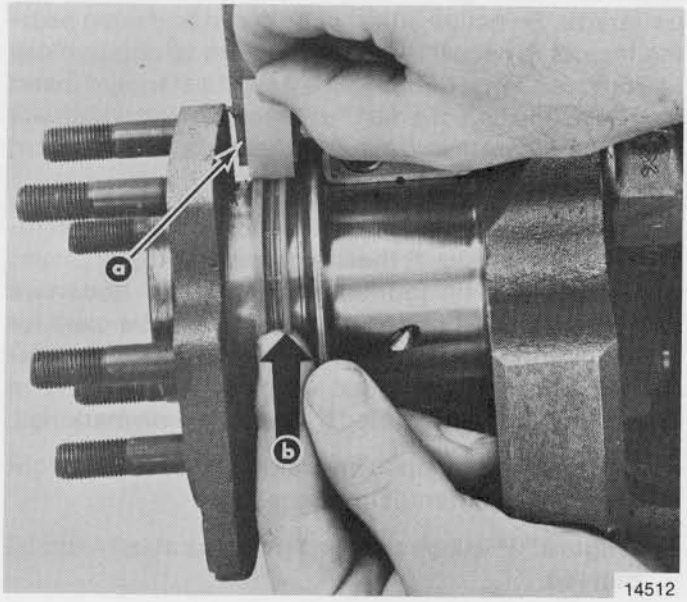
1. Coat lips and sealing bead on new rear oil seal with engine oil. Keep oil off of seal parting surfaces.

IMPORTANT: Be sure to install oil seal with lip facing toward inside of engine.

2. Install upper half of oil seal:
   a. Position tip of installation tool between crankshaft and seal seating surface in cylinder block.
   b. Position upper half of seal between crankshaft and tip of installation tool so that seal bead contacts tip of tool.
   c. Roll upper half of seal around crankshaft using installation tool as a "shoe-horn" to protect seal bead from sharp corner of seal seating surface.

IMPORTANT: Installation tool must remain in position until seal is properly positioned with both ends flush with block.

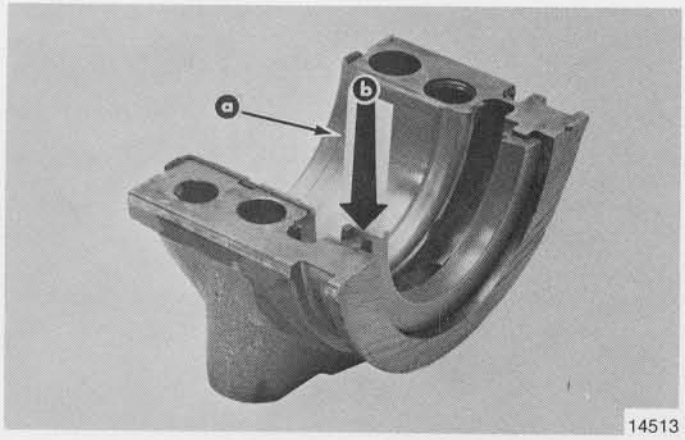
d. After both ends of seal half are flush with block, remove installation tool.



a - Installation Tool
b - Roll Seal Into Place In This Direction

Installing Upper Half of Oil Seal

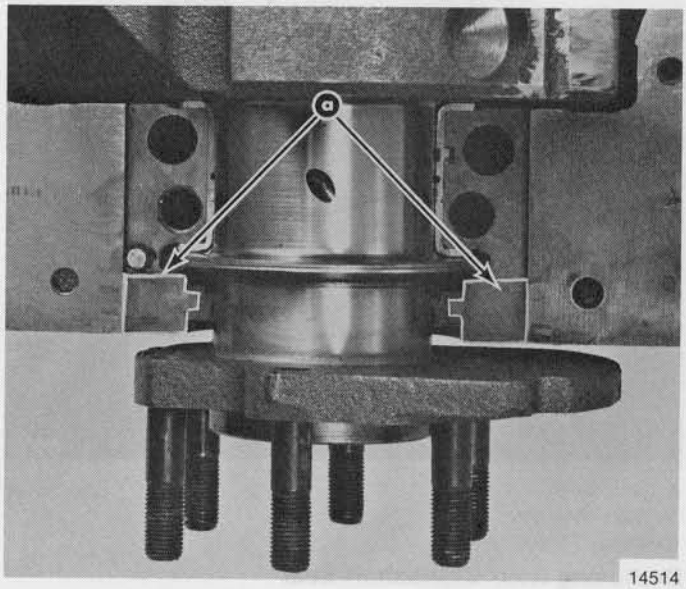
3. Install lower half of oil seal:
   a. Position oil seal half in rear main bearing cap so that one end is slightly below mating surface and seal lip is facing toward bearing. Do not allow sealing bead on other end of seal half to contact seal seating surface.
   b. Insert installation tool in between sealing bead and seal seating surface, then, using tool as a "shoe-horn" to protect sealing bead from sharp corner of seal seating surface, roll seal into place. Seal is properly positioned when both ends are flush with cap.
   c. Remove installation tool.



a - Installation Tool
b - Roll Seal Half Into Position In This Direction

Installing Lower Half of Oil Seal

4. Make sure that bearing cap and cylinder block mating surfaces and oil seal parting surfaces are clean and free of oil, then apply Perfect Seal to block at locations shown. Do not get sealer on seal parting surfaces or on surfaces adjacent to main bearing inserts.



a - Apply Perfect Seal to Outlined Area Only

Applying Sealer to Block

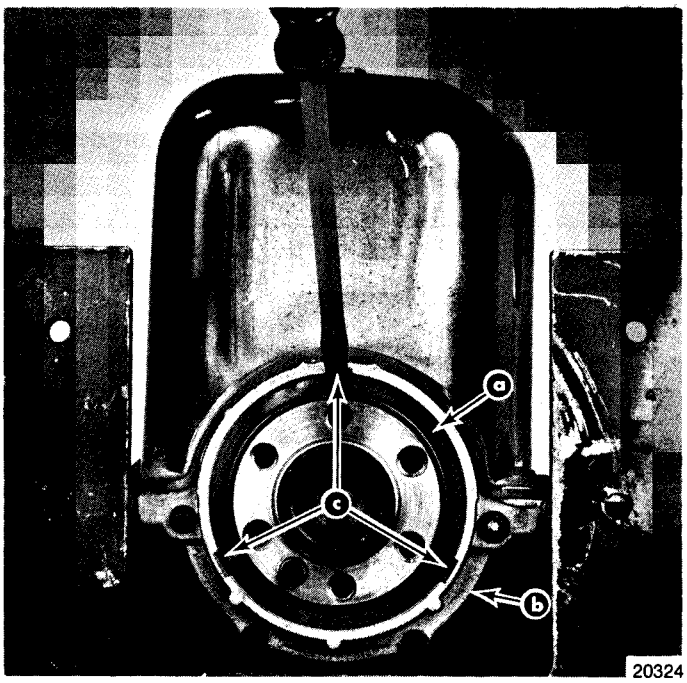
5. Install rear main bearing cap and torque attaching bolts to 10-12 ft. lbs. (13-16 N.m). Tap crankshaft first rearward and then forward with a lead hammer to line up rear main bearing thrust surfaces. With crankshaft in forward position, torque rear main bearing cap attaching bolts evenly (alternating from side to side) to specifications.
6. Install oil pump and oil pan as outlined.

Oil Seal (New Style Rear)

The new style rear crankshaft oil seal can be replaced without removing the oil pan or rear main bearing cap from engine.

Removal

1. Remove seal by prying out by the three slots located in the seal retainer.



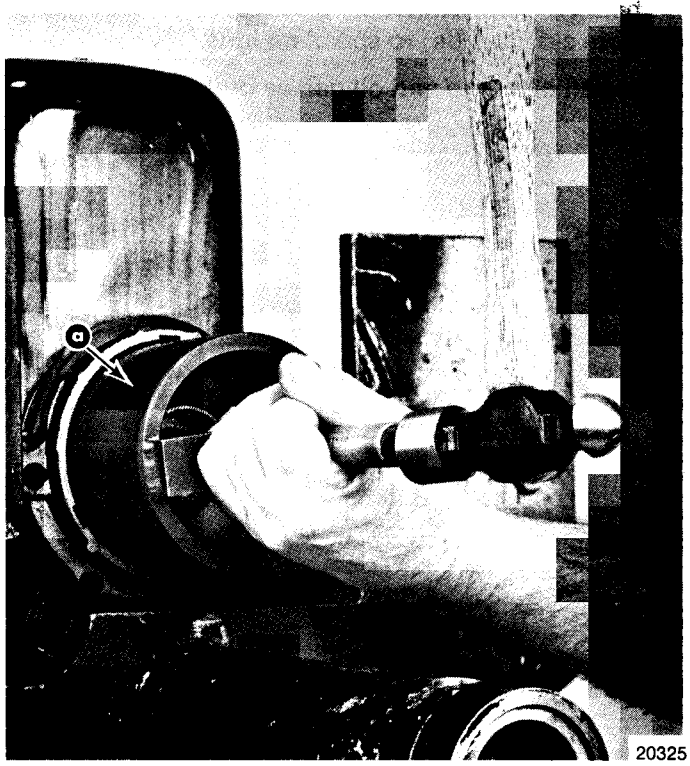
a - Rear Seal
b - Seal Retainer
c - Slots (Three)

Removing Rear Crankshaft Seal

2. Clean crankshaft/seal running surface and seal retainer.

Installation

1. Apply Perfect seal to seal retainer mating surface. Apply grease to seal lips.
2. Install seal with Kent Moore tool J-26817-A.



a - Kent Moore Tool J-26817-A

Installing Seal

Main Bearings

Main bearings are precision insert type and do no utilize shims for adjustment. If clearances are excessive, a new bearing (both upper and lower halves) will be required. Bearings are available in standard size and undersize. Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. Consequently, one half of a standard insert may have one half of a .001" undersize insert which will decrease clearance .005" from using a full standard bearing.

When a production crankshaft cannot be precision fitted by this method, it then is ground .009" (.229mm) undersize on main journals only. A .009" undersize bearing and .010" undersize bearing may be used for precision fitting in the same manner as previously described. Any engine fitted with a .009" undersize crankshaft will be identified by the following markings:

- ".009" will be stamped on crankshaft counterweight forward of center main journal.
- A figure "9" will be stamped on block at left front oil pan rail.
- A crankshaft with an undersize journal will be painted with light green on each side of the affected journal.

IMPORTANT: If crankshaft has an undersize journal and a new bearing is required, journal must be reconditioned to accept a .010" or a .020" undersize bearing as .009" undersize bearings are not available for service.

Inspection

In general (except No. 2 bearing), lower half of bearing shows a greater wear and most distress from fatigue. After inspection, if lower half is suitable for use, it can be assumed that the upper half also is satisfactory. If lower half is worn or damaged, both upper and lower halves should be replaced. Never replace one half without replacing the other.

Checking Clearance

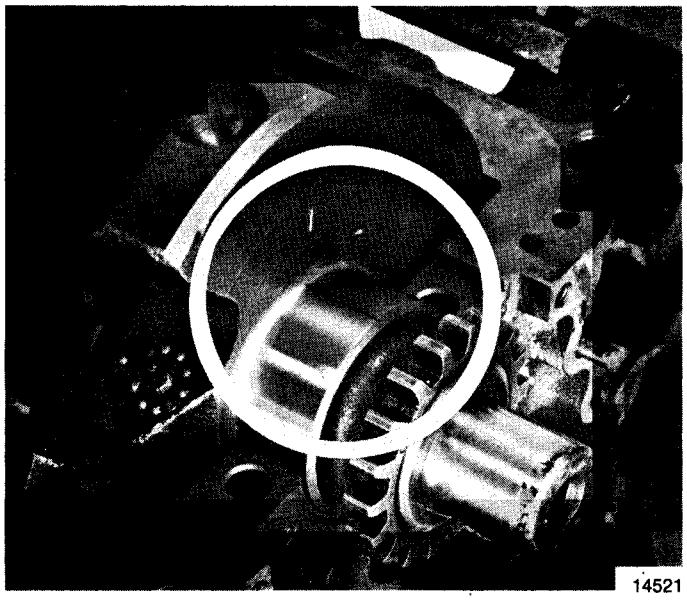
To obtain best results, use Plastigage (or its equivalent), a wax-like plastic material which will compress evenly between bearing and journal surfaces without damaging either surface. With engine upside-down, crankshaft will rest on upper bearings, and total clearance can be measured between lower bearing and journal.

IMPORTANT: To assure proper seating of crankshaft, all bearing cap bolts should be at their specified torque. In addition, surface of crankshaft journal and bearing should be wiped clean of oil before checking fit of bearings. Remove oil seal from rear main bearing cap prior to checking clearance.

1. With oil pan, baffle (some engines) and oil pump removed (starting with rear main bearing), remove bearing cap and wipe oil from journal and bearing cap.
2. Place a piece of gauging plastic full width of bearing (parallel to crankshaft) on journal.

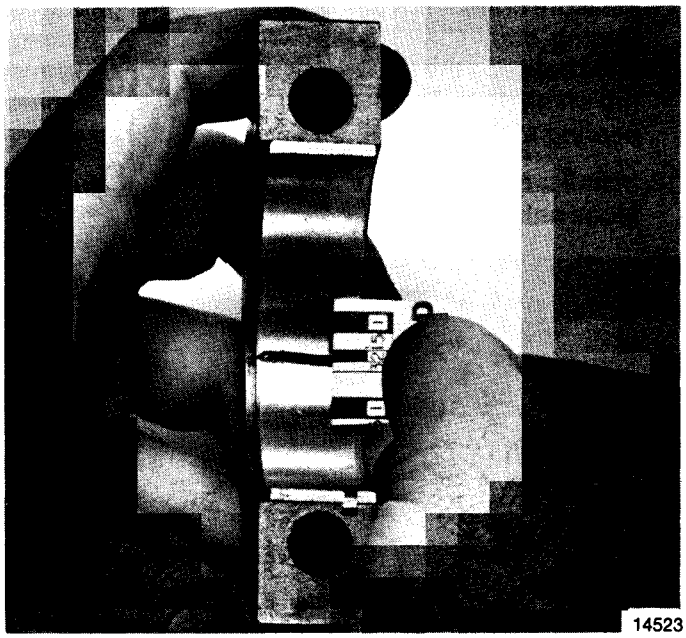
IMPORTANT: Do not rotate crankshaft while gauging plastic is between bearing and journal.

3. Install bearing cap and torque retaining bolts evenly to specifications.



Gauging Plastic on Journal

4. Remove bearing cap. Flattened gauging plastic will be found adhering to either bearing shell or journal.
5. Use graduated scale (correlated in thousandths of an inch) on edge of gauging plastic envelope. Without removing gauging plastic, measure its compressed width (at widest point) with graduations on gauging plastic envelope.



Measuring Gauging Plastic

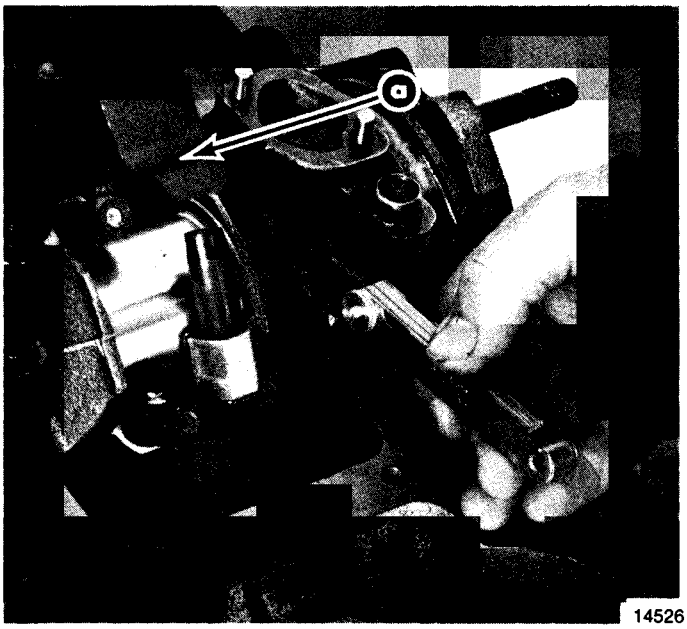
IMPORTANT: Main bearing journals usually wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal (.001" [.25mm] maximum), be sure to fit to maximum diameter of journal. If bearing is fitted to minimum diameter, and journal is out-of-round .001", interference between bearing and journal will result in rapid bearing failure. If flattened gauging plastic tapers toward middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of bearing or journal. Be sure to measure journal wiht a micrometer if flattened gauging plastic indicates more than .001" difference.

6. If bearing clearance is within specifications, bearing insert is satisfactory. If clearance is not within specifications, replace the insert. Always replace both upper and lower insert as a unit.

IMPORTANT: If a new bearing cap is being installed and clearance is less than .001", inspect for burrs or nicks.

7. A standard .001" or .002" undersize bearing may produce proper clearance. If not, regrind crankshaft journal for use with next undersize bearing.
8. Proceed to next bearing. After all bearings have been checked, rotate crankshaft to see that excessive drag does not exist.
9. Install front 4 main bearing caps and torque evenly to specifications.
10. Install rear main bearing cap and torque attaching bolts to 10-12 lbs. ft. (13-16 N.m) Tap end of crankshaft first rearward and then forward with a hammer to align rear main bearing thrust surfaces. With crankshaft in forward position, torque rear main bearing attaching bolts evenly (alternating from side to side) to specifications.

11. Measure crankshaft end play with a feeler gauge by forcing crankshaft forward and measuring clearance between the front of the rear main bearing and the crankshaft. If clearance is excessive rear main bearing and/or crankshaft must be replaced.
12. Install a new rear main bearing oil seal in cylinder block and main bearing cap, as outlined.

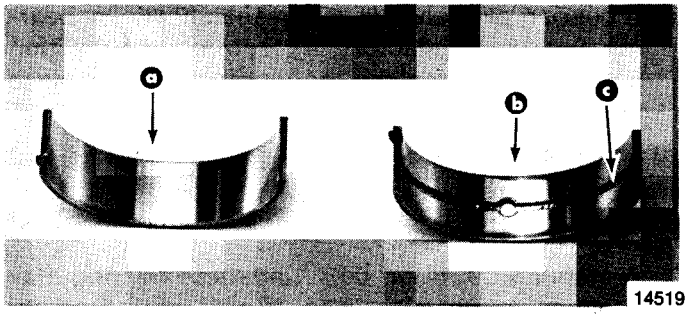


a - Force Crankshaft Forward

Measuring Crankshaft End Play

Replacement

NOTE: Main bearings may be replaced with or without removing crankshaft.



a - Lower Bearing Insert (Install in Cap)
b - Upper Bearing Insert (Install in Block)
c - Oil Groove

Main Bearing Inserts

WITH CRANKSHAFT REMOVED:

1. Remove and inspect crankshaft.
2. Remove main bearings from cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in cylinder block and main bearing caps.
4. Install crankshaft.

WITHOUT CRANKSHAFT REMOVED:

1. With oil pan, baffle (some engines), oil pump and spark plugs removed, remove cap on main bearing requiring replacement and remove bearing from cap.
2. Replace main bearing upper half as follows:
   a. Install main bearing removing and installing tool in crankshaft journal oil hole.

NOTE: If tool is not available, bend a cotter pin.

   b. Rotate crankshaft clockwise (as viewed from front of engine). This will roll upper bearing out of block.
   c. Oil new selected size upper bearing and insert plain (unnotched) end between crankshaft and notched side of block. Rotate bearing into place and remove tool from oil hole in crankshaft journal.
3. Oil new lower bearing and install in bearing cap.
4. Install main bearing cap with arrows pointing toward front of engine.
5. Torque main bearing cap bolts to specifications.

Connecting Rod Bearings

Connecting rod bearings are precision insert type and do not utilize shims for adjustment. Do not file rods or rod caps. If clearances are found to be excessive, a new bearing will be required. Bearings are available in standard size and undersize for new and used standard size crankshafts and reconditioned crankshafts.

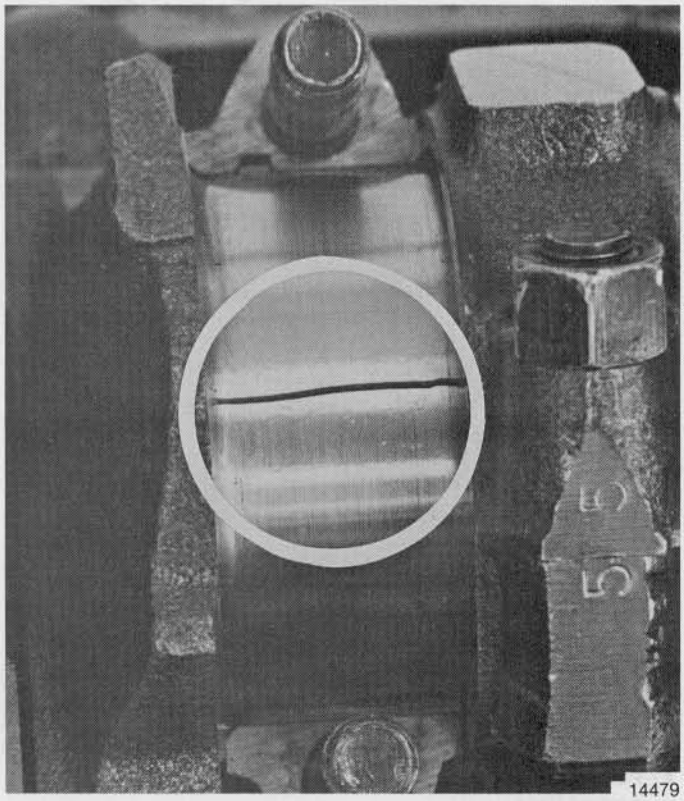
Inspection and Replacement

1. With oil pan and oil pump removed, remove connecting rod cap and bearing.
2. Inspect bearing for wear or damage and replace unsatisfactory bearings.
3. Wipe bearings and crankpin clean of oil.
4. Measure crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition crankshaft. If within specifications, and a new bearing is to be installed, measure maximum diameter of crankpin to determine new bearing size required.
5. Measure new or used bearing clearances with Plastigage or its equivalent.

IMPORTANT: If a bearing is being fitted to an out-of-round crankpin, be sure to fit to maximum diameter of crankpin. If bearing is fitted to minimum diameter, and crankpin is out-of-round .001" (.025mm) or more, interference between bearing and crankpin will result in rapid bearing failure.

a. Install bearing in connecting rod and cap.

b. Place a piece of gauging plastic the full width of crankpin (parallel to crankshaft).



14479

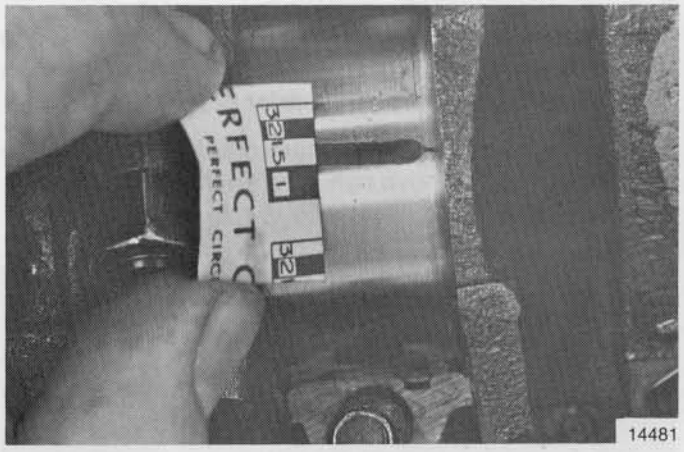
Gauging Plastic on Crankpin

c. Install bearing cap and torque nuts evenly to specifications.

IMPORTANT: Do not turn crankshaft with gauging plastic installed.

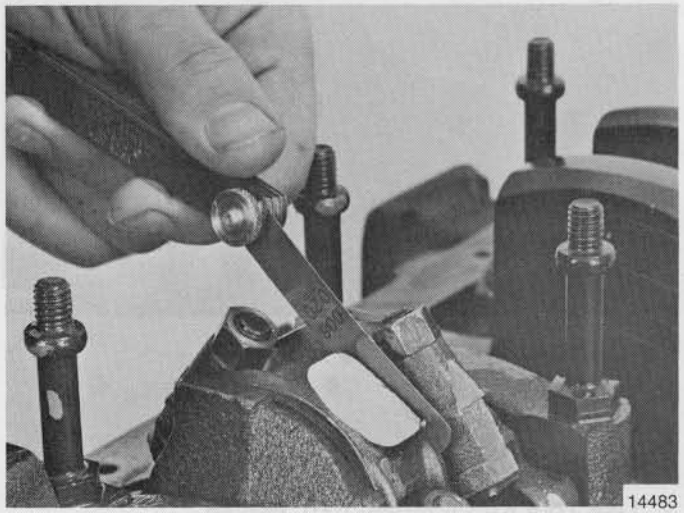
d. Remove bearing cap and, using scale on gauging plastic envelope, measure gauging plastic width at the widest point.

6. If clearance exceeds specifications, select a new, correct size bearing and recheck clearance.
7. Coat bearing surface with oil, install rod cap and torque nuts to specifications.
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to crankpin) to make sure they have clearance.
9. Measure all connecting rod side clearances (see specifications) between connecting rod caps.



14481

Measuring Gauging Plastic



14483

Measuring Connecting Rod Side Clearance

Connecting Rod/Piston Assembly

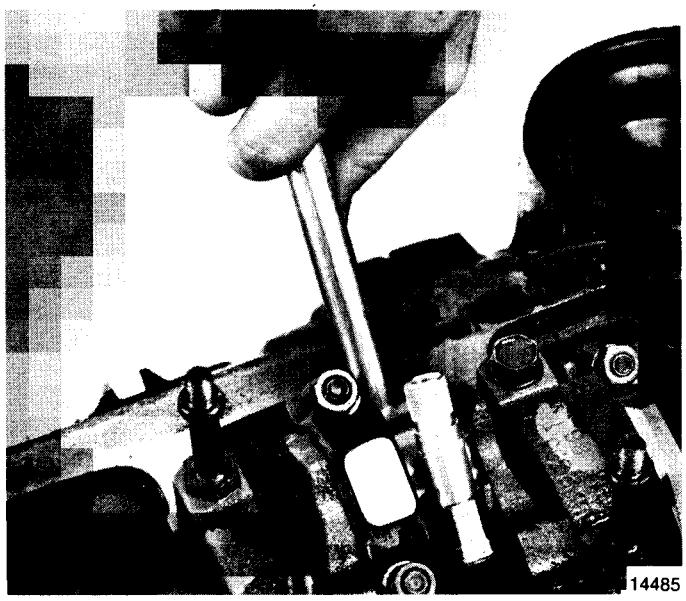
Removal

1. With oil pan, baffle (some engines), oil pump and cylinder head removed, use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

2. Mark connecting rod and bearing caps left bank 1, 3, 5 and 7; right bank 2, 4, 6 and 8 from front to rear on same side as piston thrust.
3. Remove connecting rod cap and install tool J-5239 (3/8") on bolts. Push connecting rod and piston assembly out of top of cylinder block.

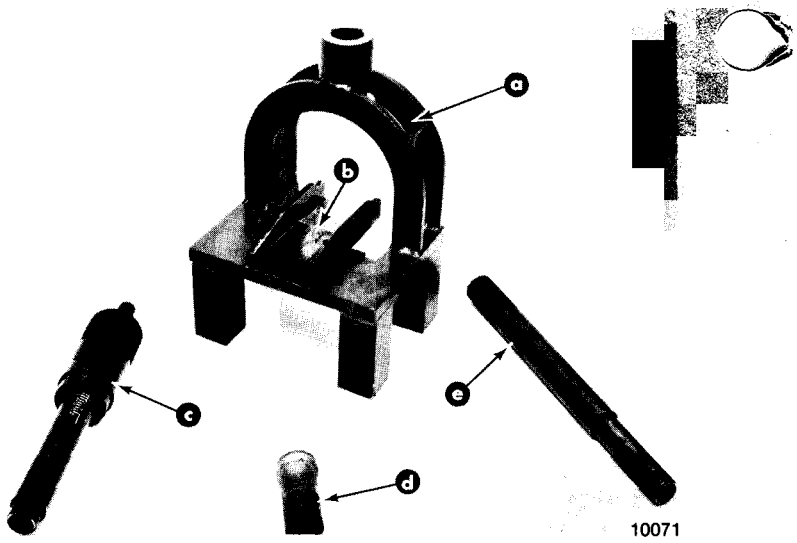
NOTE: It will be necessary to turn crankshaft slightly to disconnect and remove some connecting rod and piston assemblies.



Removing Piston Assembly

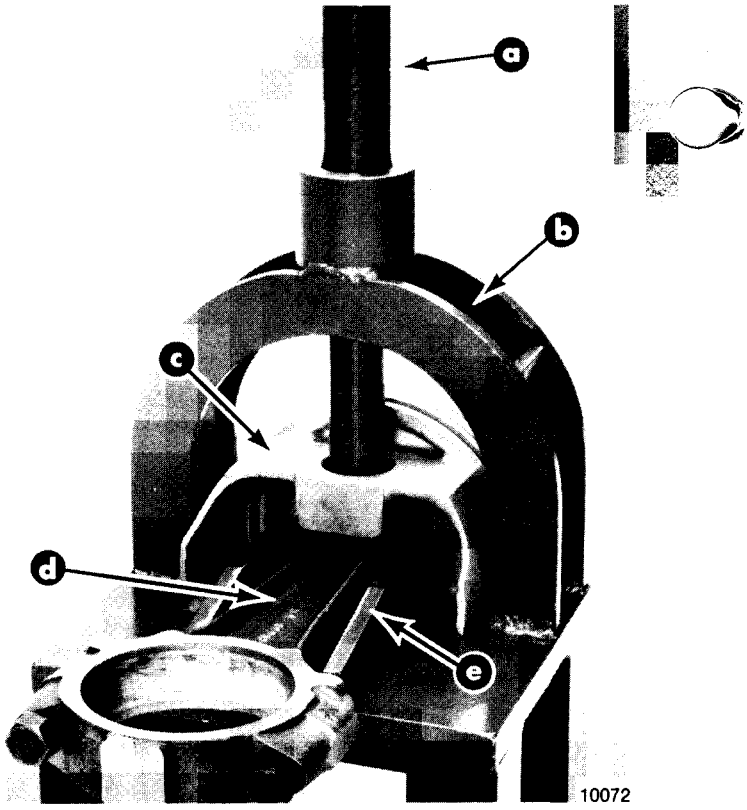
Disassembly

1. Use Tool Kit (J-24086-100), shown.
2. Position connecting rod onto tool rod support with rod support inserted between connecting rod end and piston. Align piston pin with hole located in top of arched base.
3. Insert pin remover thru hole (located in top of arched base) and into piston pin hole. Press on pin remover to remove piston pin.



a - Arched Base
b - Rod Support
c - Adjustable Installer
d - Piston Pin Guide
e - Piston Pin Remover

Tool (J-24086-100) Parts Identification



a - Piston Pin Remover
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

Removing Piston Pin

Cleaning and Inspection

CONNECTING RODS

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted or bent rods and inspect for nicks or cracks. Replace damaged connecting rods.

PISTONS

1. Clean varnish from piston skirts and pins with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with a groove cleaner and make sure oil ring holes and slots are clean.
2. Inspect piston for cracked ring lands, skirts or pin bosses, wavy worn ring lands, scuffed or damaged skirts or eroded areas at top of piston. Replace pistons which are damaged or show signs of excessive wear.
3. Inspect grooves for nicks or burrs that might cause rings to hang up.
4. Measure piston skirt and check clearance as outlined under "Piston Selection - Cylinder Block".

PISTON PINS

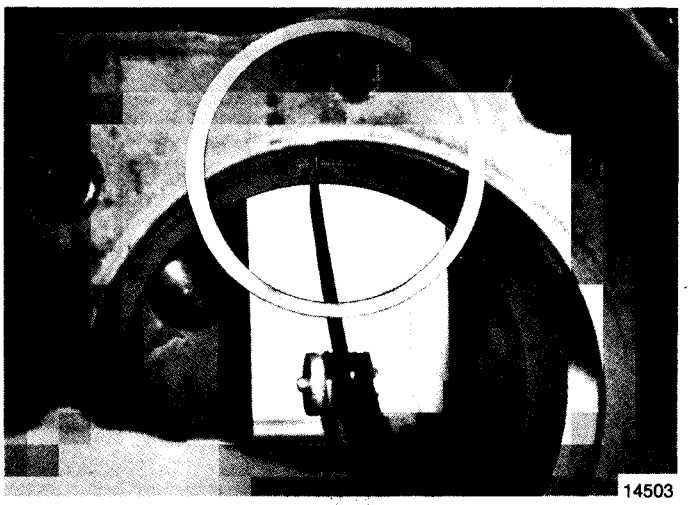
1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.
2. Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish or scuffing when measured. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of the .001" (.025mm) wear limit, replace piston and piston pin assembly.

PISTON RINGS

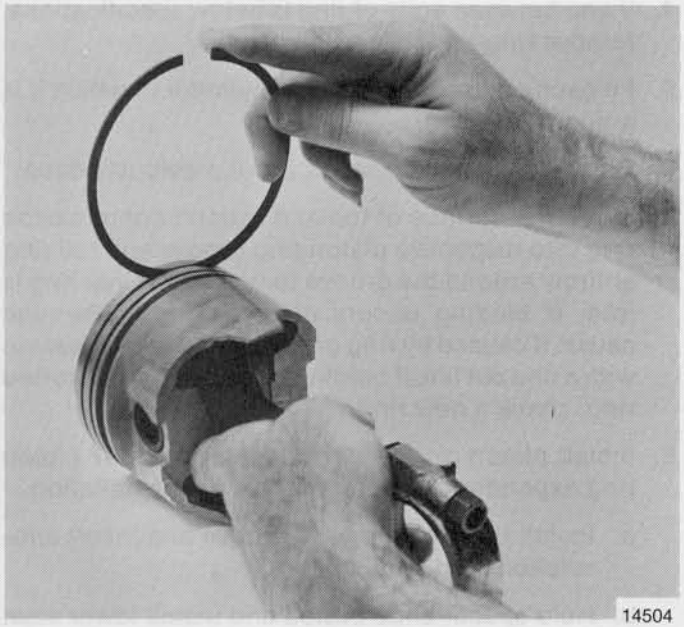
All compression rings are marked on upper side of ring. When installing compression rings, make sure that marked side is toward top of piston.

Oil control rings are a 3-piece type, consisting of 2 segments (rails) and a spacer.

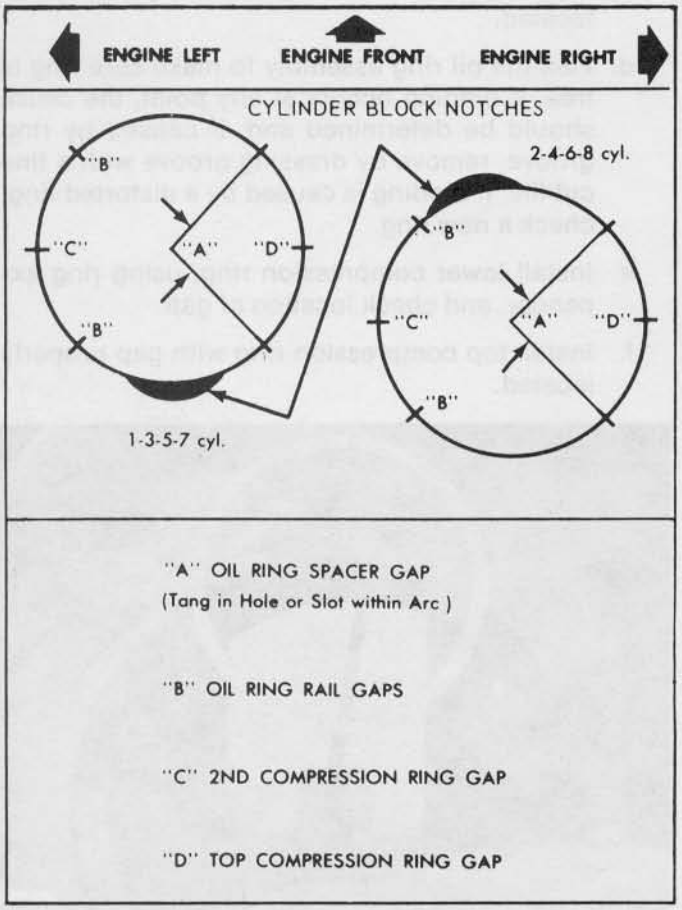
1. Select rings comparable in size to piston being used.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4" (6mm) (below ring travel). Be sure that ring is square with cylinder wall.
3. Measure gap between ends of ring with a feeler gauge.
4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it is going to be used.
6. Clean and inspect pistons, if not previously done.
7. Slip outer surface of top and second compression ring into respective piston ring groove and roll ring entirely around the groove to make sure that ring is free. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, check a new ring.
8. Install piston ring as shown. Use 91-24697 piston ring expanders for compression ring installation.
   a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex the oil ring assembly to make sure ring is free. If binding occurs at any point, the cause should be determined and, if caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, check a new ring.
   e. Install lower compression ring, using ring expander, and check location of gap.
   f. Install top compression ring with gap properly located.



Checking Ring Gap

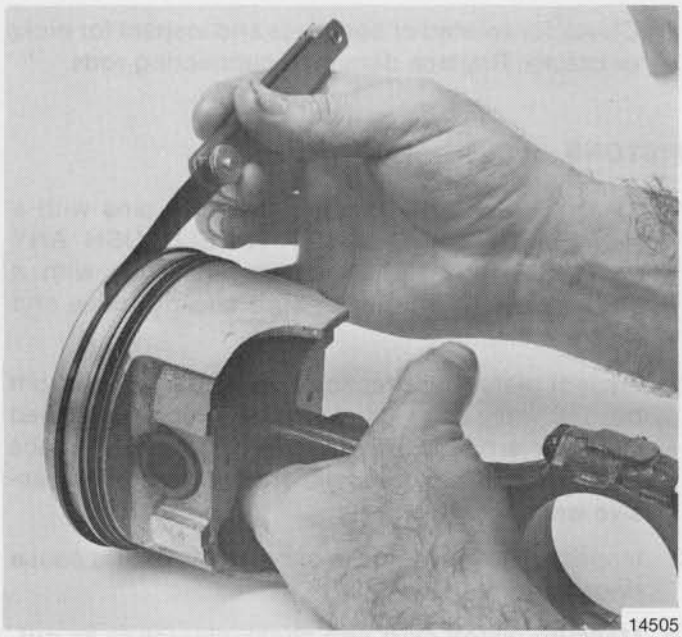


Rolling Ring in Ring Groove



Ring Gap Location

9. Proper clearance of piston ring in its piston ring groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. See "Specifications".



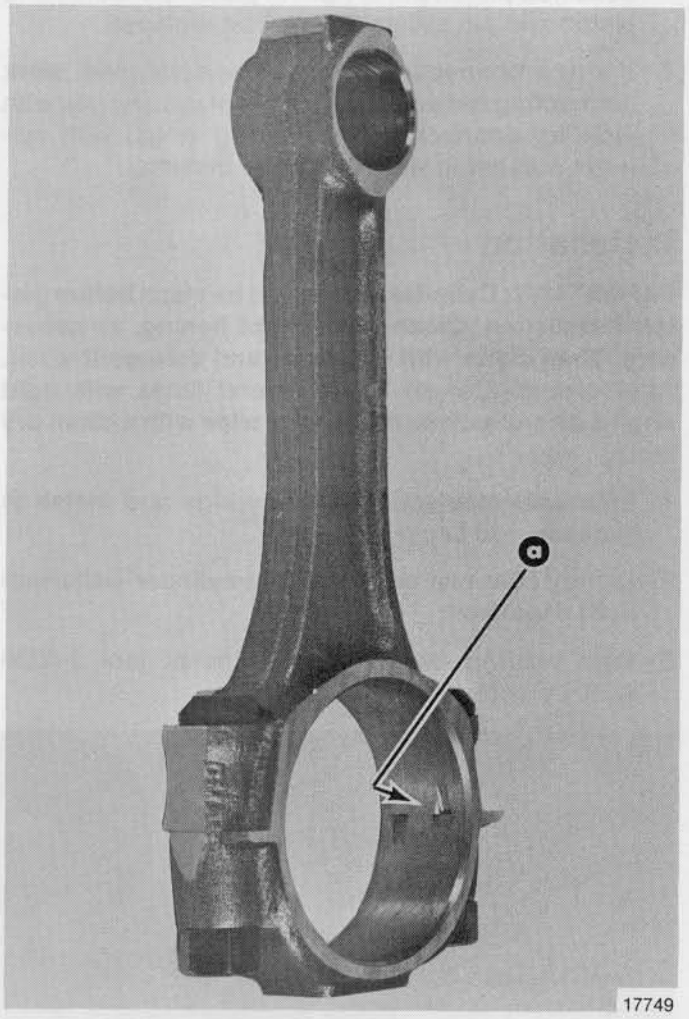
Checking Groove Clearance

Reassembly

IMPORTANT: When reassembling pistons and connecting rods, the following must be kept in mind.

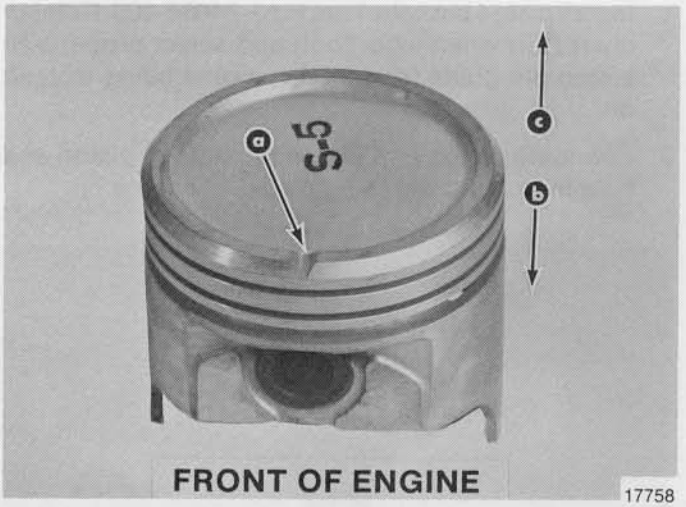
- **Piston and pin are machine fitted to each other and must remain together as a matched set. Do not intermix pistons and pins.**
- **If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.**
- **Connecting rod bearing tangs are always toward outside of cylinder block.**

- **Reference mark on piston, must be positioned correctly for engine that is being repaired.**
- **To determine if engine is left-hand (standard) rotation or right-hand (opposite) rotation, inspect camshaft drive. If engine has a timing chain, engine is left-hand rotation. If engine has timing gears, engine is right-hand rotation. All MCM engines are left-hand rotation.**



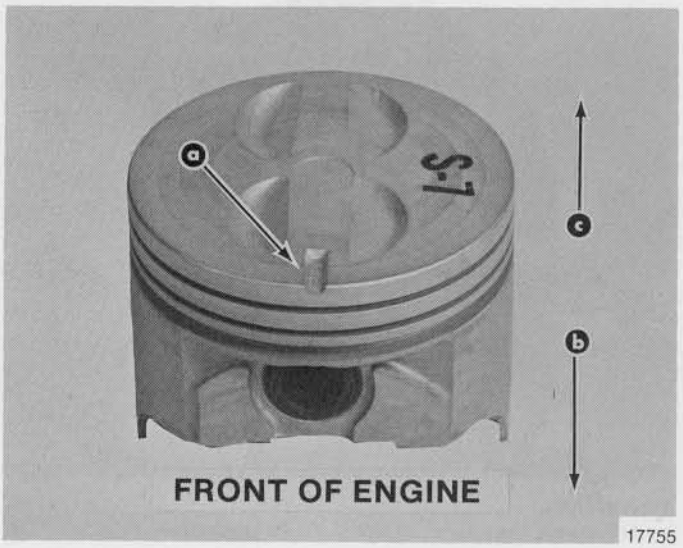
a - Connecting Rod Bearing Tangs Must Face Toward Outside of Cylinder Block

Connecting Rod



a - Notch
b - MCM and MIE L.H. Rotation Engines - Notch Toward Front of Engine
c - MIE R.H. Rotation Engines - Notch Toward Rear of Engine

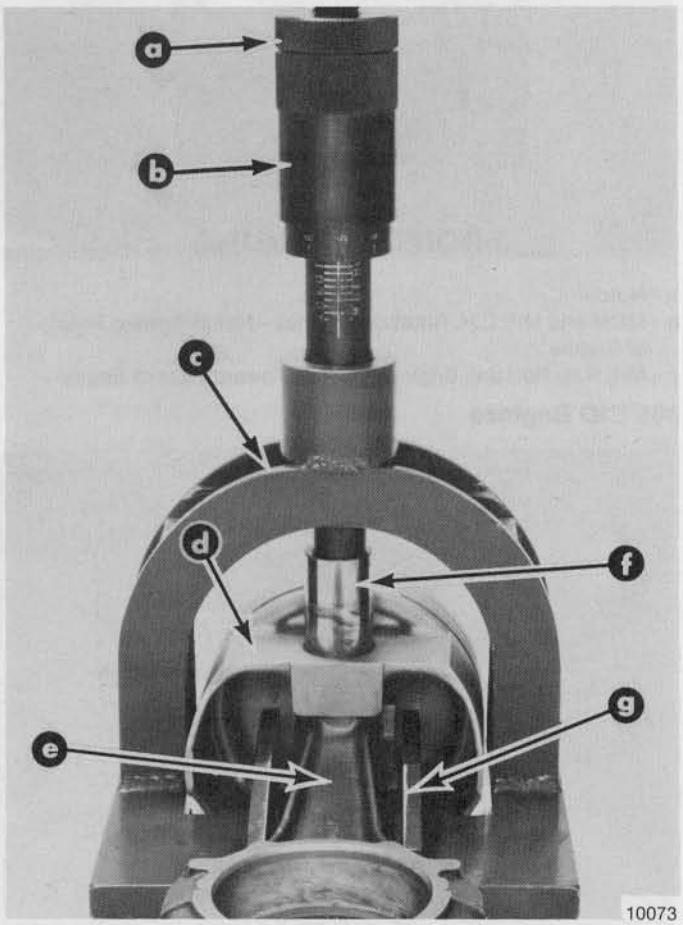
305 CID Engines



a - Notch
b - MCM and MIE L.H. Rotation Engines - Notch Toward Front of Engine
c - MIE R.H. Rotation Engines - Notch Toward Rear of Engine

350 CID Engines

1. Install piston pin with Tool Kit J-24086-100. Refer to chart (furnished with Tool) and select proper size piston pin guide for specific engine being worked on.
2. Lubricate piston pin, piston pin hole in piston and hole in rod end with a light coat of engine oil.



a - Jam Nut
b - Adjustable Installer
c - Arched Base
d - Piston
e - Connecting Rod
f - Piston Pin
g - Rod Support

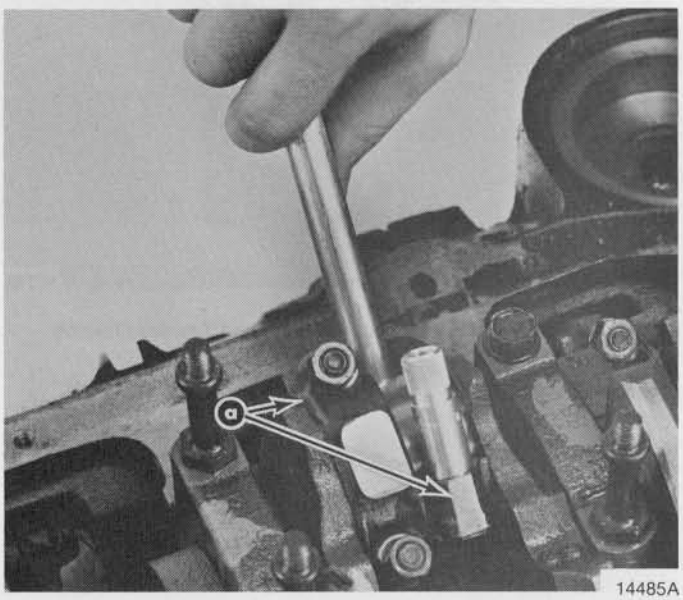
Installing Piston Pin

3. Position rod onto rod support and piston onto rod end. Insert piston pin guide thru bottom piston pin hole and into connecting rod. Place piston pin thru top side of piston.
4. Adjust adjustable installer to setting specified on chart (which came with tool) for particular piston installation. Lock adjustable installer with jam nut.
5. Insert adjustable installer thru hole (located on top of arched base) and into piston pin hole. Carefully press on adjustable installer until installer bottoms-out on arched base to install piston pin.
6. Check piston for freedom of movement in piston pin bores by moving connecting rod back-and-forth and up-and-down. Connecting rod should move freely (with no resistance) in both directions. If it does not, piston pin is tight in piston pin bores and piston and pin assembly must be replaced.
7. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

Installation

IMPORTANT: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, swab bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install tool J-5239 (3/8") on connecting rod bolts.



a - Connecting Rod Bearing Tangs Toward Outside of Cylinder Block

Connecting Rods - Installed Position

Installing Connecting Rod and Piston Assemblies

IMPORTANT: Be sure ring gaps are properly positioned as previously outlined.

4. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tangs toward outside of cylinder block. Use tool J-8307 to compress rings. Guide connecting rod into place on crankshaft journal with tool J-5239. Use a hammer handle with light blows to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3, 5 and 7 in left bank and 2, 4, 6 and 8 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.

5. Remove tool J-5239.
6. Install bearing caps and torque nuts to specification.
7. Check connecting rod side clearance.

NOTE: If bearing replacement is required, refer to "Connecting Rod Bearings".

8. Install the following items:
   a. Oil Pump
   b. Baffle (if equipped)
   c. Oil Pan
   d. Cylinder Head
9. Install engine in boat.
10. Fill crankcase with oil.
11. Start engine, adjust timing and check for leaks.

Crankshaft

Removal

1. Remove engine from boat.
2. Drain coolant and crankcase oil. Disconnect all hoses.
3. Remove starter motor, flywheel housing and flywheel. Place engine in repair stand.
4. Remove belts, crankshaft pulley and water pump.
5. Remove torsional damper and crankcase front cover.
6. Remove spark plugs.
7. Remove camshaft sprocket and timing chain. (Left-hand rotation engines only.)
8. Remove oil pan and oil pump.
9. Make sure all bearing caps (main and connecting rods) are marked so they can be installed in their original locations.
10. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.
11. Remove main bearing caps and carefully lift crankshaft out of cylinder block. Remove rear main bearing oil seal from cylinder block and rear main bearing cap.
12. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings following procedures outlined in this section. (See "Index".)

Cleaning and Inspeciton

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize (see "Specifications").
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in "V" blocks) and check at front and rear intermediate journals with a dial indicator (see "Specifications").
4. Replace or recondition crankshaft if not meeting specifications.

Installation

1. If a new crankshaft is being installed, proceed as follows:
   a. Remove timing sprocket or gear from old crankshaft and reinstall on new crankshaft.
   b. **On I-Drive Engines:** Remove flywheel attaching studs from old crankshaft, using heat if necessary. Reinstall studs in new crankshaft with Loctite 35 applied to threads.

IMPORTANT: Be sure that all bearings and crankshaft journals are clean.

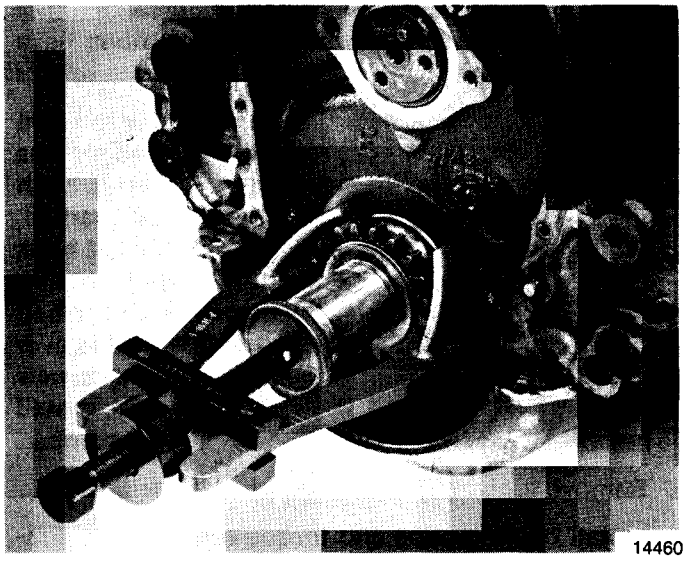
2. Install a new rear main bearing oil seal in cylinder block and rear main bearing cap.
3. Carefully lower crankshaft into place. Be careful not to damage bearing surface.
4. Check clearance of each main bearing, following procedure outlined under "Main Bearing"; see "Index". If bearing clearances are satisfactory, apply a light coat of engine oil to journals and bearings.
5. Install all bearing caps and bolts. Torque all main bearing cap bolts to specifications. When tightening rear main bearing cap. Follow procedure outlined under "Main Bearing"; see "Index".
6. Check clearance for each connecting rod bearing, following procedure under "Connecting Rod Bearings"; see "Index". If bearing clearances are satisfactory, apply a light coat of engine oil to journals and bearings.
7. Install all rod caps and torque nuts to specifications.
8. Check crankshaft end play. Follow procedure outlined under "Main Bearing"; see "Index".
9. Install oil pump and pan as outlined.
10. Install camshaft sprocket and timing chain. (Left-hand rotation engines only.)
11. Install crankcase front cover and torsional damper.
12. Remove engine from repair stand and install water pump, flywheel, flywheel housing and starter motor.
13. Install crankshaft pulley and belts.
14. Install spark plugs.
15. Install engine in boat, fill crankcase and install hoses.

Crankshaft Sprocket/Gear

Removal

1. Remove torsional damper and crankcase front cover as outlined.
2. Remove camshaft timing chain as outlined.
3. Using tool shown in chart, remove sprocket or gear.

350 CID ENGINE	J-1619

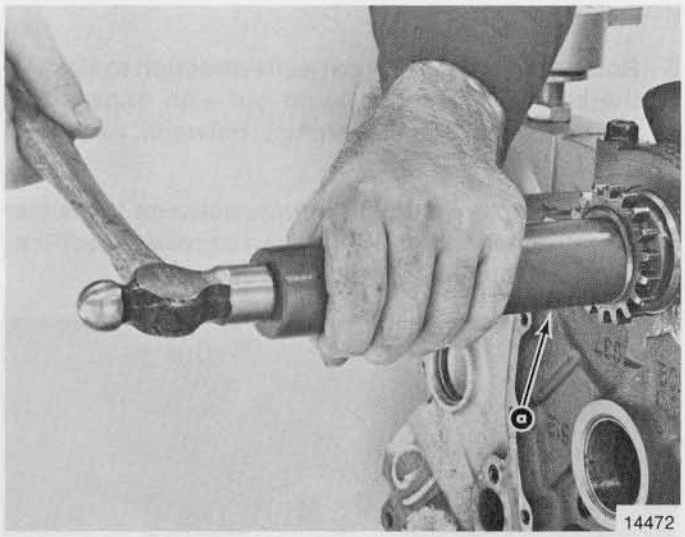


14460

J-1619 Puller

Installation

1. Using correct tool as shown, install sprocket or gear.
2. Install camshaft timing chain as outlined.
3. Install crankcase front cover and torsional damper as outlined.



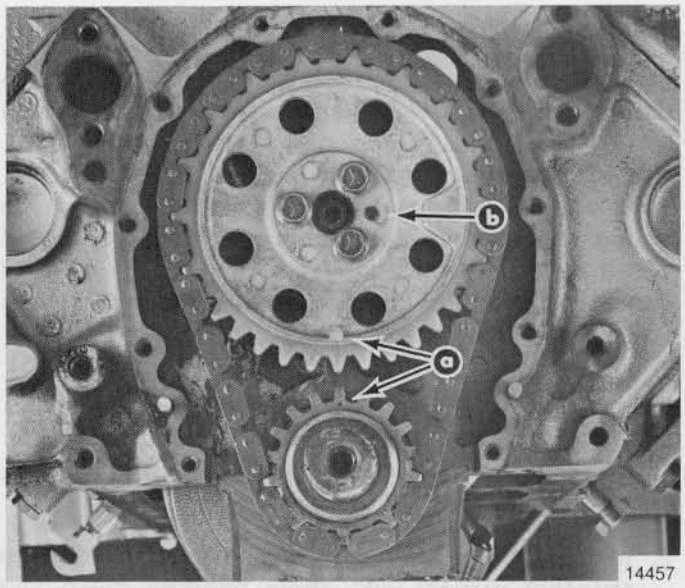
a - Tool J-5590

305/350 CID Engines

Timing Chain/Sprockets Left-Hand (Standard) Rotation Engines

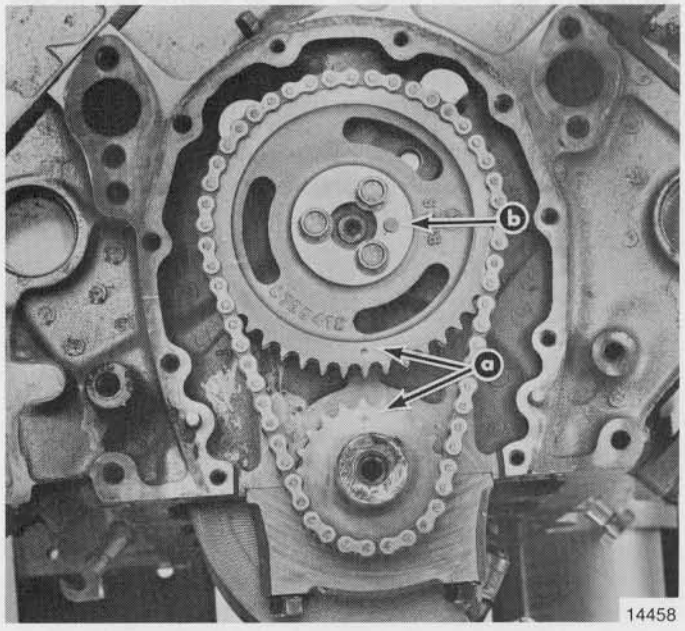
Removal

1. Remove torsional damper and crankcase front cover as outlined.
2. Crank engine until marks on camshaft and crankshaft sprockets are in alignment.
3. Remove camshaft sprocket to camshaft bolts.
4. Remove camshaft sprocket and timing chain together. Sprocket is a light press fit on camshaft. If sprocket does not come off easily, a light blow on lower edge of sprocket (with a plastic mallet) should dislodge the sprocket.
5. If crankshaft sprocket has to be replaced, remove as outlined in "Crankshaft Sprocket/Gear".



a - Timing Marks Aligned
b - Locating Pin

305/350 CID Engines Aluminum/Nylon Camshaft Sprocket



a - Timing Marks Aligned
b - Locating Pin

305/350 CID Engines All Metal Camshaft Sprocket

Cleaning and Inspection

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing chain for wear or damage.
3. Inspect sprockets for wear or damage.

Replacement Part Information

Some engines were originally equipped with link type timing chain and timing sprockets that have nylon teeth. If any of these components require replacement, a new timing chain assembly (35378A1) must be used. The timing chain assembly consists of a new roller type timing chain, an all-metal camshaft timing sprocket and a new crankshaft timing sprocket. The original components cannot be used in any combination with these replacement components.

Installation

1. If crankshaft sprocket was removed, install as outlined in "Crankshaft Sprocket/Gear".
2. Install timing chain on camshaft sprocket. Hold sprocket vertical with chain hanging down and orient to align marks on camshaft and crankshaft sprockets.

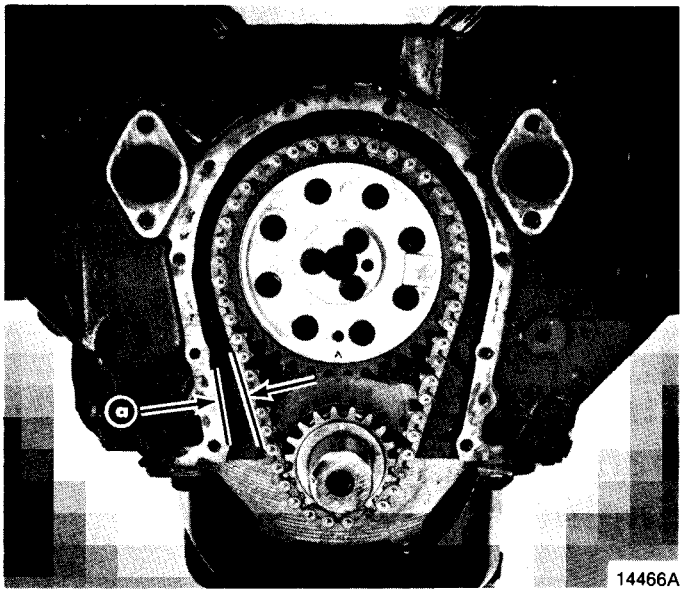
IMPORTANT: Do not attempt to drive sprocket on camshaft, as welsh plug at rear of engine can be dislodged.

3. Draw camshaft sprocket onto camshaft, using the 3 mounting bolts. Torque to specifications.
4. Lubricate timing chain with engine oil. Install crankcase front cover and torsional damper as outlined.

Checking Timing Chain Deflection

With timing chain and sprockets installed, check timing chain deflection, as follows:

1. Rotate camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.
4. The deflection is the difference between these two measurements. If the deflection exceeds specifications, timing chain should be replaced.



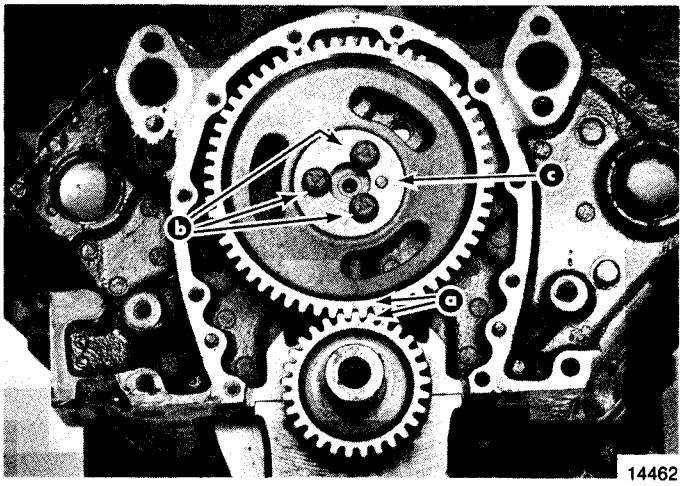
a - Reference Point

Checking Timing Chain Deflection

Timing Gears Right-Hand (Opposite) Rotation Engines

Removal

1. Remove oil pan, torsional damper and crankcase front cover as outlined.
2. Crank engine over until timing mark on camshaft timing gear aligns with timing mark on crankshaft timing gear.



14462

a - Timing Marks
b - Screws
c - Locating Pin

Timing Marks Aligned

3. Remove camshaft timing gear attaching screws (and washers if so equipped) and remove gear. If gear does not come off easily, a light blow on the lower edge of the gear with a plastic mallet should dislodge the gear.
4. If crankshaft timing gear requires replacement, remove as outlined in "Crankshaft Sprocket/Gear" (see "Index").

Cleaning and Inspection

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing gears for worn or damaged teeth.
3. Inspect camshaft gear to cylinder block contact surfaces for damage.

Installation

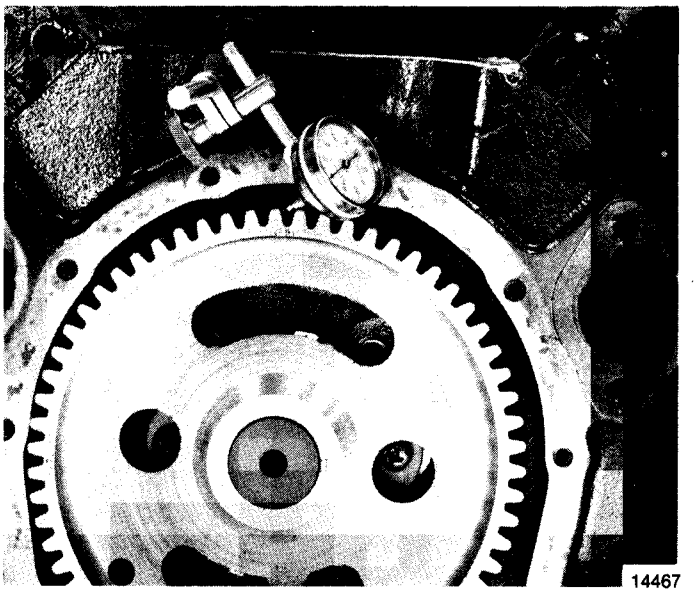
1. If removed, install crankshaft timing gear as outlined in "Crankshaft Sprocket/Gear".
2. Position camshaft timing gear so that timing mark aligns with timing mark on crankshaft timing gear, then align camshaft dowel with hole in camshaft gear and install gear on camshaft.
3. Install 3 camshaft timnig gear attaching screws (and washers if so equipped) and draw sprocket onto camshaft. After sprocket is in place, torque screws to specifications.

IMPORTANT: Do not attempt to drive gear on camshaft, as welsh plug at rear of engine can be dislodged.

4. Check timing gear backlash and runout as explained under "Checking Backlash and Runout".
5. Lubricate timing gears with engine oil.
6. Install crankcase front cover, oil pan and torsional damper as explained.

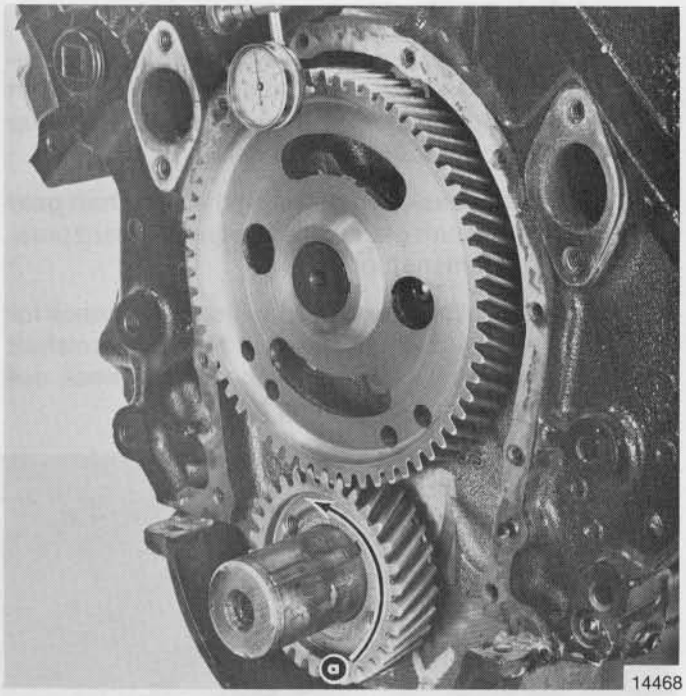
Checking Backlash and Runout

1. Remove fuel pump and fuel pump push rod.
2. Loosen rocker arm nuts (to relieve tension on hydraulic valve lifters).
3. With timing gears installed, check camshaft to crankshaft gear backlash, as follows:
   a. Mount a dial indicator on engine so that indicator stem contacts one of the teeth on camshaft gear. Indicator stem should be as perpendicular to gear tooth surface as possible.
   b. Check the backlash between the camshaft gear and crankshaft gear while applying inward pressure on camshaft gear.
   c. If backlash is not within specifications, check for improperly machined parts or for worn camshaft or crankshaft bearings. If bearings check out good, replace both timing gears.


14467

Checking Backlash

4. With timing gear installed, check camshaft and crankshaft timing gear runout, as follows:
   a. Mount dial indicator on block so that indicator stem is perpendicular to camshaft timing gear and contacts gear surface just adjacent to teeth.
   b. Apply inward pressure on timing gear and zero indicator, then turn crankshaft as shown. Check gear runout through one complete revolution of camshaft gear.
   c. If not within specifications, check for burrs or foreign material between gear and camshaft joining surfaces. If none is found, replace both timing gears.
   d. Check crankshaft timing gear runout in same manner. Runout should not exceed specifications. Replace both gears, if runout is excessive.
5. Adjust rocker arm nuts.
6. Install fuel pump push rod and fuel pump.



a - Turn Crankshaft In This Direction

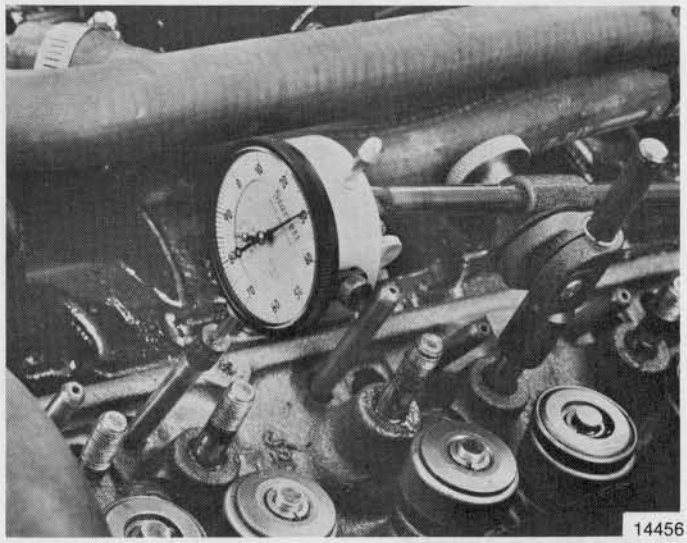
Checking Gear Runout

Camshaft

Measuring Lobe Lift

NOTE: Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.

1. Remove valve mechanism as outlined.
2. Position indicator with ball socket adapter Tool J-8520-1 on push rod. Be sure that push rod is in lifter socket.



Measuring Camshaft Lobe Lift

3. Rotate crankshaft damper slowly in direction of rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
4. Set dial indicator on zero, then rotate balancer slowly (or attach an auxiliary starter switch and "bump" engine over) until push rod is in fully raised position.
5. Compare total lift, recorded from dial indicator, with "Specifications".
6. Continue to rotate engine until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install and adjust valve mechanism as outlined.

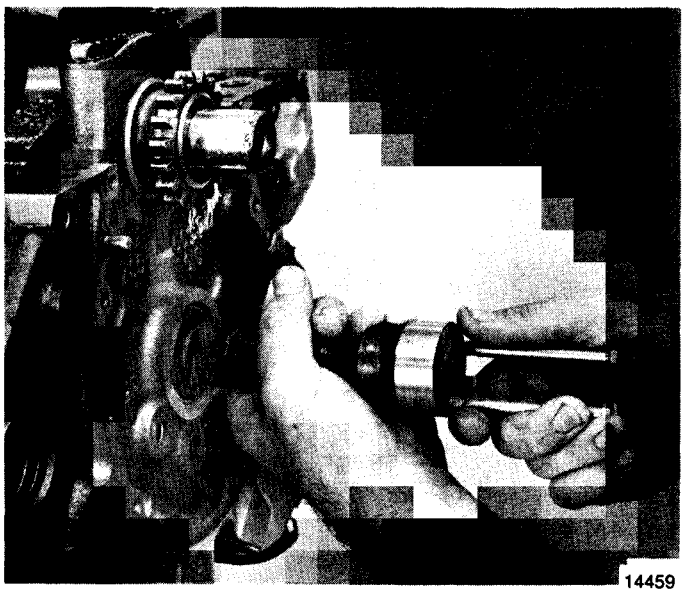
Removal

1. Remove valve lifters as outlined.
2. Remove crankcase front cover as outlined.
3. Remove fuel pump and fuel pump push rod.
4. Remove camshaft as follows:

MCM and MIE L.H. Rotation Engines:

a. Refer to "Timing Chain/Sprockets, Left-Hand (Standard) Rotation Engines" to remove chain and sprocket.

b. Install two 5/16-18 bolts in camshaft sprocket bolt holes and carefully remove camshaft.



Removing Camshaft

MIE R.H. Rotation:

a. Refer to "Timing Gears, Right-Hand (Opposite) Rotation Engines" to remove timing gear.

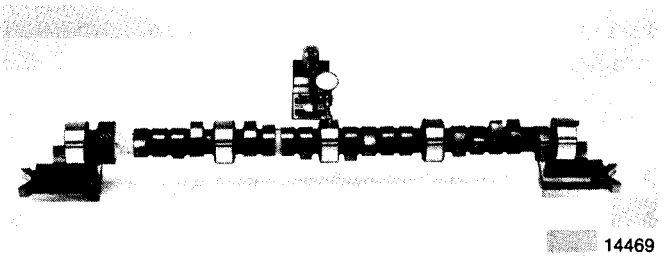
b. Install two 5/16-18 bolts in camshaft gear bolt holes and carefully remove camshaft.

Inspection

Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001" (.025mm) out-of-round, camshaft should be replaced.

Also check camshaft for alignment with "V" blocks and dial indicator which indicates exact amount camshaft is out-of-true. If out more than .002" (.051mm) (dial indicator reading) camshaft should be replaced.

On engines with timing gears, inspect camshaft gear and thrust plate for wear or damage.



Checking Camshaft Alignment

Installation

1. Install camshaft as follows:

MCM and MIE L.H. Rotation Engines:

a. Install two 5/16-18 bolts in camshaft bolt holes, then lubricate camshaft journals with engine oil and install camshaft, being careful not to damage bearings. Remove the two 5/16-18 bolts.

b. Install timing chain and sprocket as outlined in "Timing Chain/Sprockets, Left-Hand (Standard) Rotation Engines".

MIE R.H. Rotation Engines:

a. Install two 5/16-18 bolts in camshaft bolt holes, then lubricate camshaft journals with engine oil and install camshaft, being careful not to damage bearings. Remove the two 5/16-18 bolts.

b. Install timing gear as outlined in "Timing Gears, Right-Hand (Opposite) Rotation Engines".

2. Lubricate camshaft drive system with engine oil.
3. Install fuel pump push rod and fuel pump.
4. Install crankcase front cover and valve lifters as outlined.

Camshaft Bearings

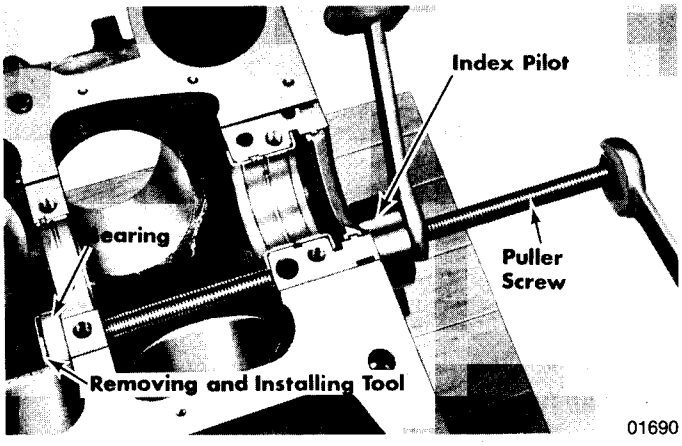
Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft. Fasten connecting rod against sides of engine so that they will not interfer while replacing camshaft bearings.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

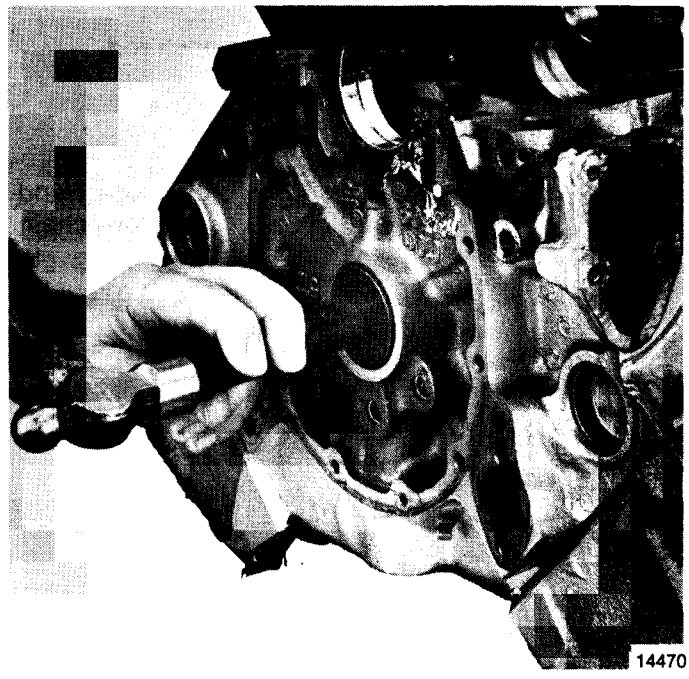
NOTE: This procedure is based on removal of bearings center of engine first, thus requiring a minimum amount of turns to remove all bearings.

2. Using tool set J-6098-01 (with nut and thrust washer installed to end of threads), position pilot in front camshaft bearing and install puller screw through pilot.
3. Install tool with shoulder toward bearing. Be sure a sufficient amount of threads are engaged.
4. Using 2 wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove tool and bearing from puller screw.
5. Remove remaining bearings (except front and rear) in same manner. It will be necessary to position pilot in rear camshaft bearing to remove rear intermediate bearing.



Replacing Camshaft Bearings

6. Assemble remover tool on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block.



Replacing Front and Rear Camshaft Bearings

Inspection

Clean camshaft bearing bores in cylinder block with solvent and blow out with compressed air. Be sure grooves and drilled oil passages are clean.

Installation

Front and rear bearings must be installed last as pilot will not fit into bearing bores if bearings are installed.

Lubricate outer surface of new camshaft bearings with engine oil to ease installation.

IMPORTANT: All camshaft bearings are not the same. Be sure to install bearing in proper location (indicated by bearing manufacturer) and to position bearings as follows: (Directional references are in reference to engine in its normal operating position.)

- **Front bearing must be positioned so that oil holes are equal distance from 6 o'clock position in the block. Intermediate and center bearings must be positioned so that oil holes are at the 5 o'clock position (toward left side of block and at a position even with bottom of cylinder bore). Rear bearing must be positioned so that oil hole is at the 12 o'clock position.**

1. **Installing Intermediate and Center Bearings:**
   a. Install nut and thrust washer all-the-way onto puller screw, then position pilot in front camshaft bearing bore and insert screw thru pilot.
   b. Index center camshaft bearing, then position appropriate size remover and installer tool in bearing and thread puller screw into tool. Be sure at least 1/2" (13mm) of threads are engaged.
   c. Using 2 wrenches, hold puller screw and turn nut until bearing has been pulled into position. Remove the remover and installer tool and check to ensure that oil hole(s) in bearing are positioned correctly.
   d. Install intermediate bearings in same manner being sure to index bearings correctly. It will be necessary to position pilot in rear camshaft bearing bore to install rear intermediate bearing.
2. **Installing Front and Rear Bearings:**
   a. Install appropriate size remover and installer tool on drive handle.
   b. Index front bearing (as explained in "Important"), and drive it into position with tool. Check position of oil hole(s) in bearing to ensure bearing is positioned correctly.
   c. Install rear bearing in same manner, being sure to index bearing correctly.
3. Install a new camshaft rear plug.

IMPORTANT: Plug must be installed flush to 1/32" (.8mm) deep and must be parallel with rear surface of cylinder block.

4. Install crankshaft and camshaft as outlined.

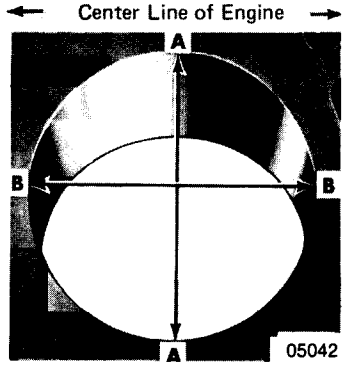
Cylinder Block

Cleaning and Inspection

1. Remove all engine components as previously outlined.
2. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
3. Remove oil gallery plugs and clean all oil passages.

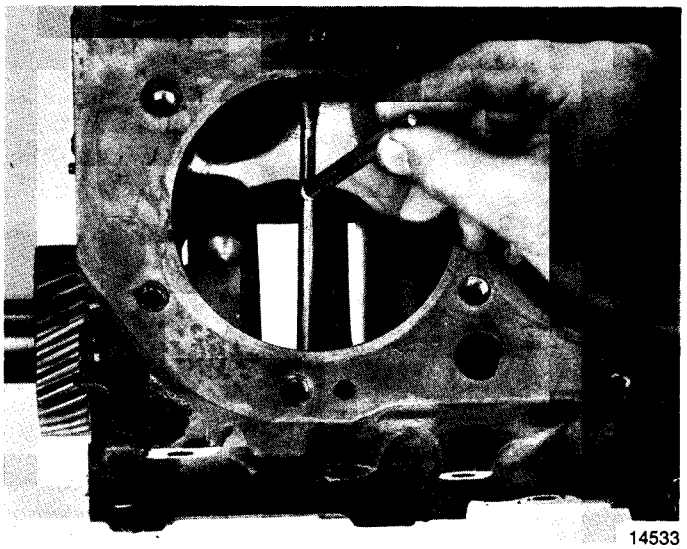
NOTE: These plugs may be removed with a sharp punch, or they may be drilled and pried out.

4. Clean and inspect water passages in cylinder block.
5. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.
6. Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring and/or honing will be necessary.



"A" = At right angle to centerline of engine
"B" = Parallel to centerline of engine
"Out-of-round" = Difference between "A" and "B"
"Taper" = Difference between measurement "A" at top of cylinder bore and "A" measurement at bottom of cylinder bore.

Cylinder Measurement



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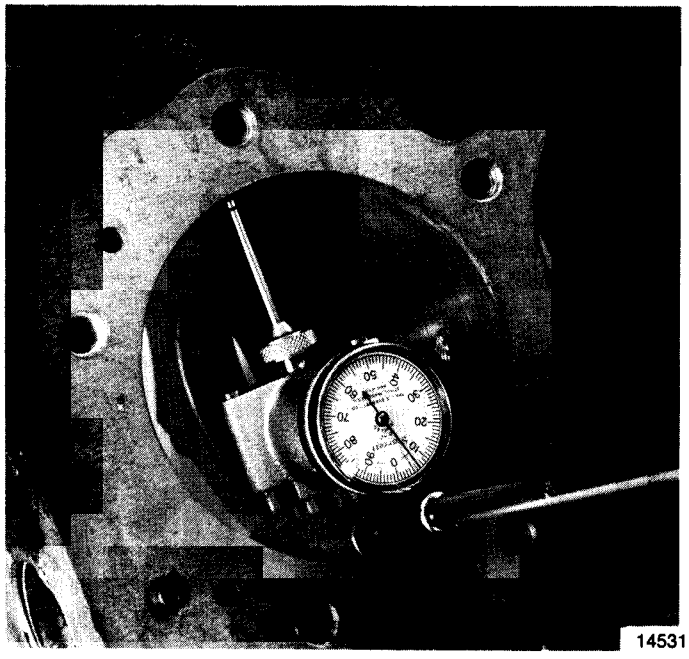
Measuring Cylinder Bore



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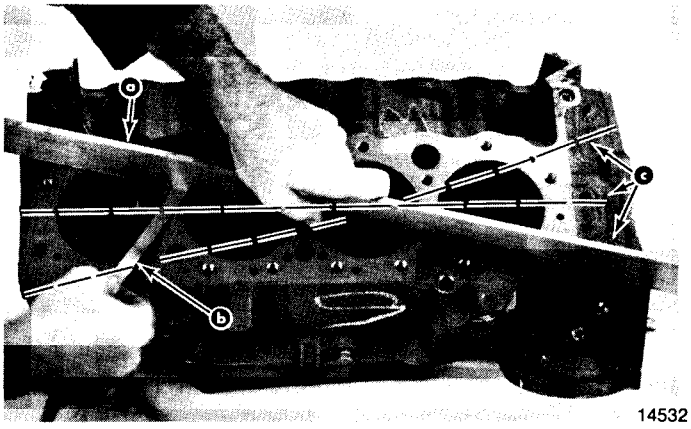
Measuring Cylinder Bore

7. Check cylinder head gasket surfaces for warpage with a machinists straight edge and a feeler gauge, as shown Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are out-of-flat more than .003" (.07mm) in a 6" area or .007" (.2mm) overall, block must be resurfaced by an automotive machine shop.



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a - Machinists Straight Edge
b - Feeler Gauge
c - Take Measurements Diagonally Across Surface and Straight Down Center

Checking Cylinder Head Gasket Surfaces for Warpage

Repairs

CYLINDER CONDITIONING

1. Performance of the following operation depends upon engine condition at time of repair.
2. If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.
3. If cylinders have less than .005" (.127mm) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of less than .005" wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to rebore for an oversize piston. If more than .005" taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
4. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER BORING

1. Before using any type boring bar, file off top of cylinder block to remove dirt or burrs. This is very important to prevent boring bar tilt, with result that rebored cylinder wall is not at right angles to crankshaft.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

NOTE: Hone cylinders as outlined under "Cylinder Honing" and "Piston Selection", following.

3. Carefully observe instructions furnished by manufacturer of equipment being used.

CYLINDER HONING

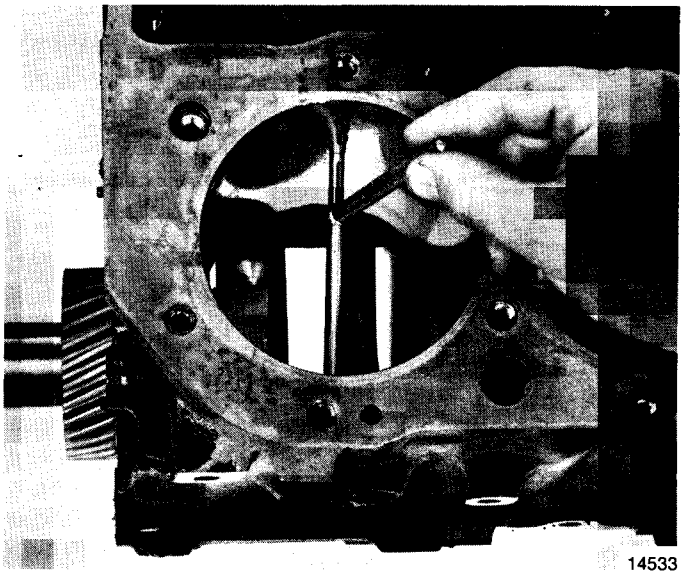
1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up-and-down at a sufficient speed to obtain very fine uniform surface finish marks in a cross-hatch pattern of approximately 30° to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as this type piston can be distorted by careless handling.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by the contaminated oil. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

PISTON SELECTION

1. Check used piston to cylinder bore clearance as follows:
   a. Measure "cylinder bore diameter" with a telescope gauge 2-1/2" (64mm) from top of cylinder bore.
   b. Measure "piston diameter" at skirt across center line of piston pin.
   c. Subtract piston diameter from cylinder bore diameter to determine "piston-to-bore clearance".
   d. Determine if "piston-to-bore clearance" is in acceptable range shown in "Specifications".
2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (preferable range).
4. Mark piston to identify cylinder for which it was fitted.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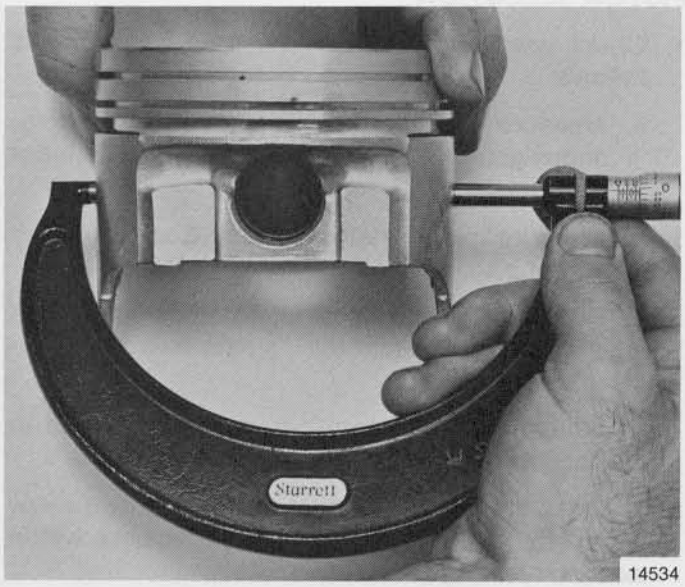
Measuring Cylinder Bore



Measuring Piston

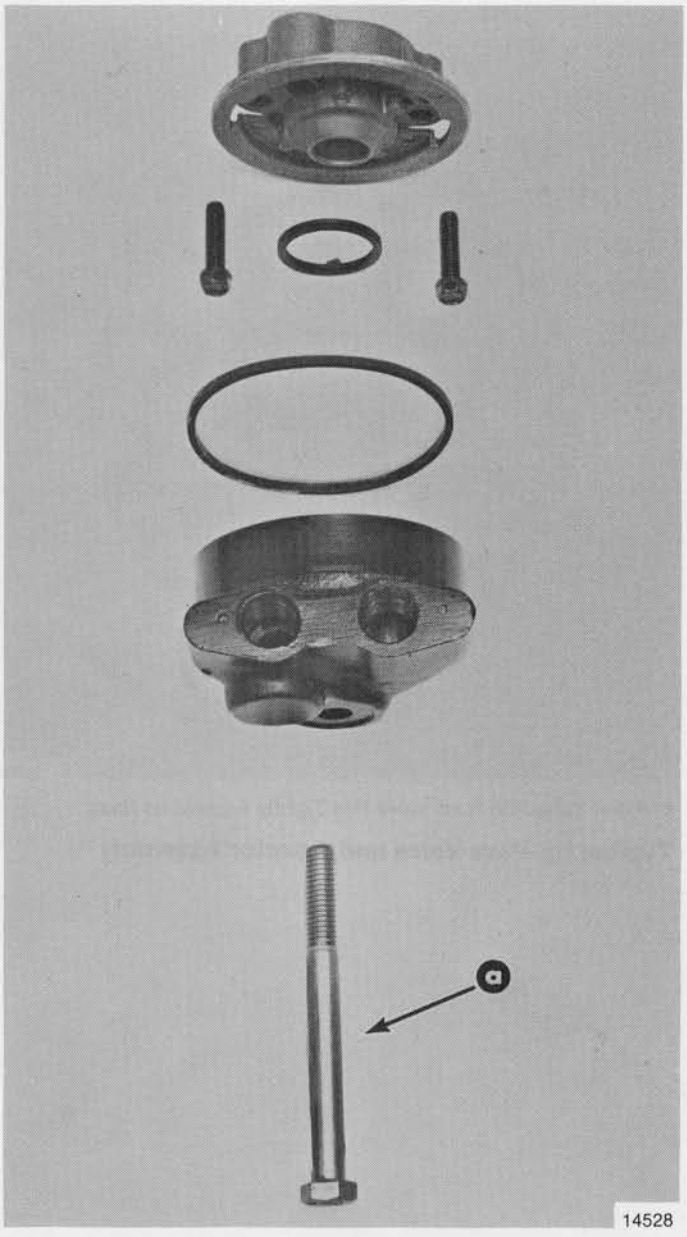
Replacement Part Information

If replacement of cylinder block is necessary, the following must be performed:

1. Retain double-ended main bearing cap attaching screws (used to support oil splash plate) for use with new engine. New engines are shipped with regular (single-ended) bolts only.
2. Retain oil filter by-pass valve and adaptor assembly and related parts for use with new engines.
3. If engine being replaced has a remote oil filter, check the cylinder block being replaced to determine method used to attach oil hoses to cylinder block Refer to "Oil Filter By-Pass Valve and Adaptor Assembly". If it uses the older style adaptor that is secured to the block with one 1/2-13 bolt, a Remote Oil Filter Adaptor Kit (90783A9) is required to adapt the remote oil filter to new block. All new blocks are machined to accept new style oil hoses to cylinder block adaptor which is secured to block with two 5/16-18 screws.

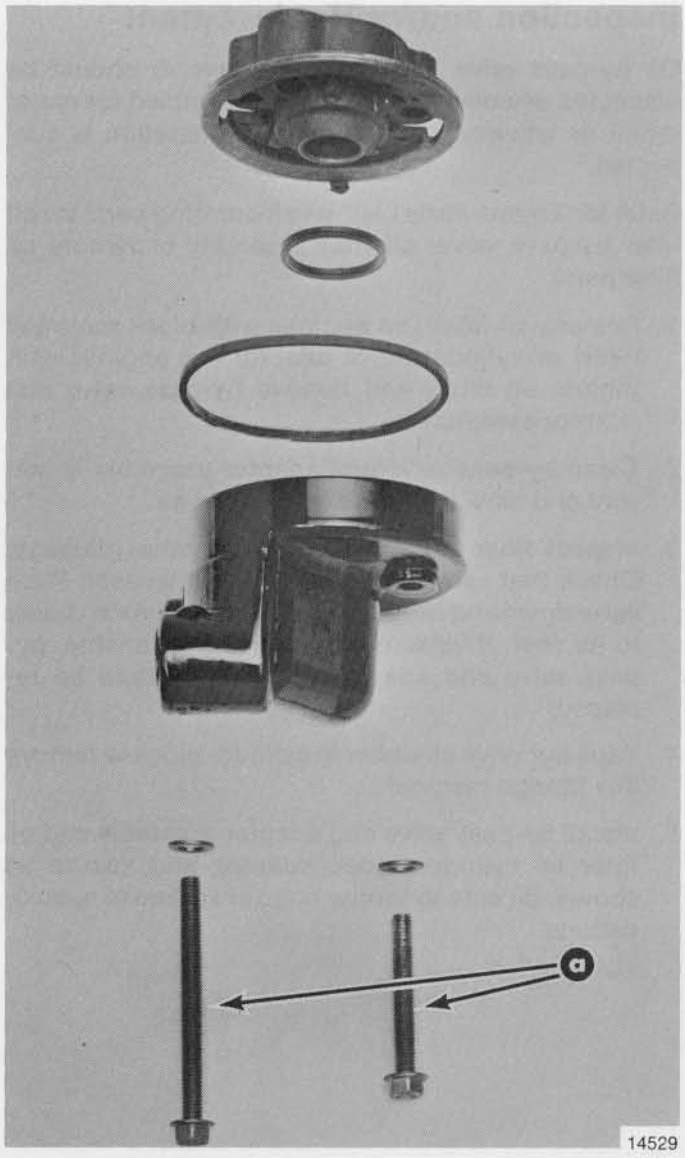
Oil Filter By-Pass Valve and Adaptor Assembly

Oil Filter By-Pass Valve and Adapator Assembly for Engines with Block Mounted Oil Filter



a - One 1/2"-13 Adaptor Attaching Bolt

Engines With Remote Oil Filter Adaptor (1/2"-13) Bolt



a - Two 5/16"-18 Adaptor Attaching Bolts

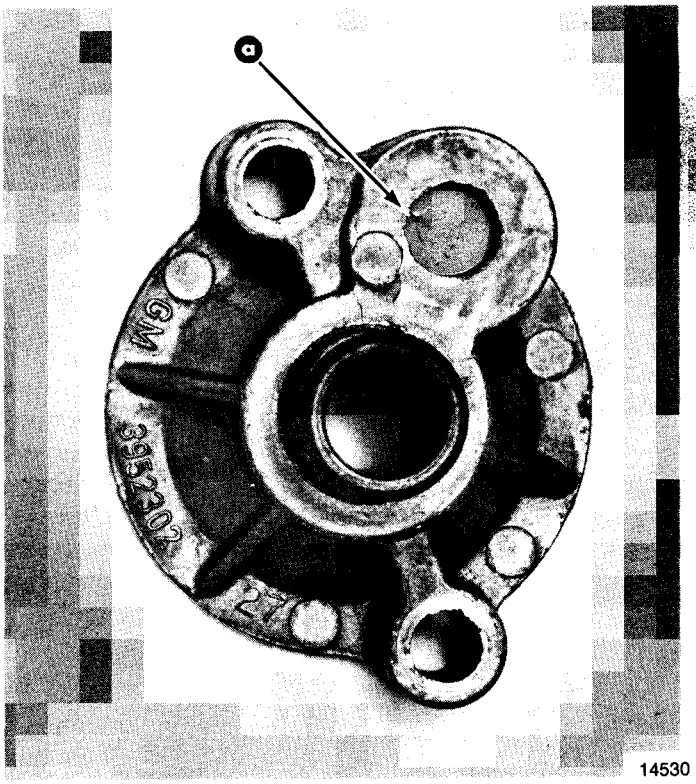
Engines With Remote Oil Filter Adaptor (5/16"-18) Bolt

Inspection and/or Replacement

Oil by-pass valve and adaptor assembly should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filteration is suspected.

Refer to "Engine Parts List" when ordering parts for oil filter by-pass valve, adaptor assembly or remote oil filter parts.

1. Remove oil filter (on engines with block mounted filter) or cylinder block adaptor (on engines with remote oil filter) and remove by-pass valve and adaptor assembly.
2. Clean by-pass valve and adaptor assembly in solvent and blow dry with compressed air.
3. Inspect fiber valve for cracks or other damage. Check that valve fits tightly against its seat. Push valve down and release it. Valve should return freely to its seat. If valve operation is questionable, by-pass valve and adaptor assembly should be replaced.
4. Wipe out valve chamber in cylinder block to remove any foreign material.
5. Install by-pass valve and adaptor assembly and oil filter or cylinder block adaptor and secure as shown. Be sure to torque bolts or screws to specifications.



a - Fiber Valve (Be Sure Valve Fits Tightly Against its Seat)

Typical By-Pass Valve and Adaptor Assembly

Remote Oil Filter Kit (92043A2) Installation Instructions

IMPORTANT: Retain existing parts unless stated otherwise.

IMPORTANT: If installing kit on engine equipped with 2 studs (16-34713) must be ordered.

⚠CAUTION

Water MUST BE drained from exhaust manifold to prevent water from entering combustion chamber when hose is removed.

MODIFY PORT EXHAUST ELBOW

1. If equipped with standard cooling system, remove hose clamp, hose and straight fitting from front of exhaust elbow. Discard fitting only. If equipped with Closed Cooling System, proceed with Step 2.
2. Coat threads of 45° fitting (from kit) with Quicksilver Perfect Seal.
3. Insert fitting in elbow opening and tighten securely. Position fitting to point toward engine. Replace hose and tighten hose clamp.
4. Remove front 2 exhaust elbow attaching nuts, washers and studs. Discard studs.

MODIFY OIL FILTER OPENING IN CYLINDER BLOCK

1. Remove and discard existing filter, 2 screws and filter valve.

INSTALL REMOTE OIL FILTER ASSEMBLY

1. Remove oil filter adaptor cover and mount adaptor body with 2 screws provided. Be sure cover seal and adaptor "O" ring are in place. Torque to 20-25 lbs. ft. (27-34 N.m).
2. Route hoses up and between exhaust manifold and engine.

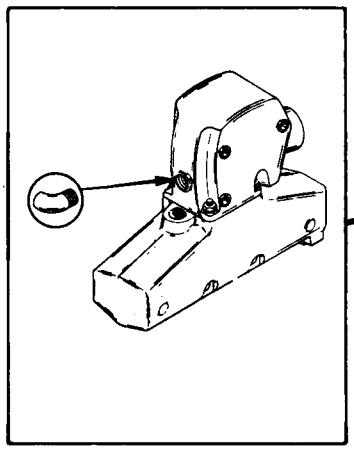
⚠CAUTION

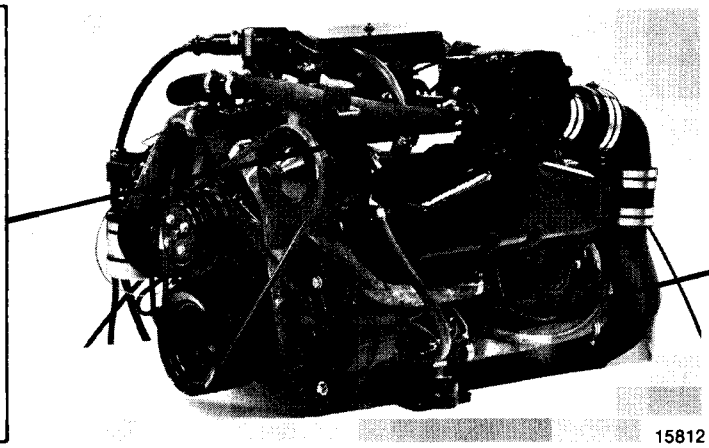
Hoses must not contact hot spots on exhaust manifold.

3. Install oil filter bracket on front of exhaust elbow. Where elbow is fastened to manifold or 6" (152mm) riser, use 2 screws (from kit) and original washers. Discard original nuts. Torque to 20-25 lbs. ft. (27-34 N.m).

NOTE: If installing kit on engine equipped with 3" (76mm) risers and replacement studs, use original washers and nuts. Discard 2 screws from kit.

4. Run engine until warm. Stop engine and wait 5 minutes. Check crankcase oil level and add oil if necessary.





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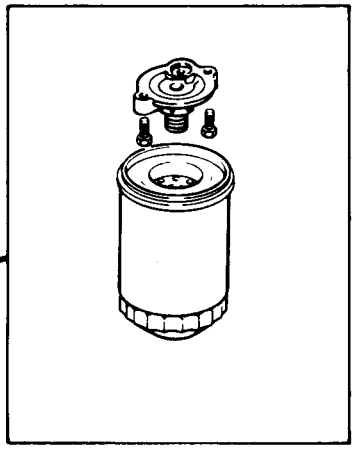
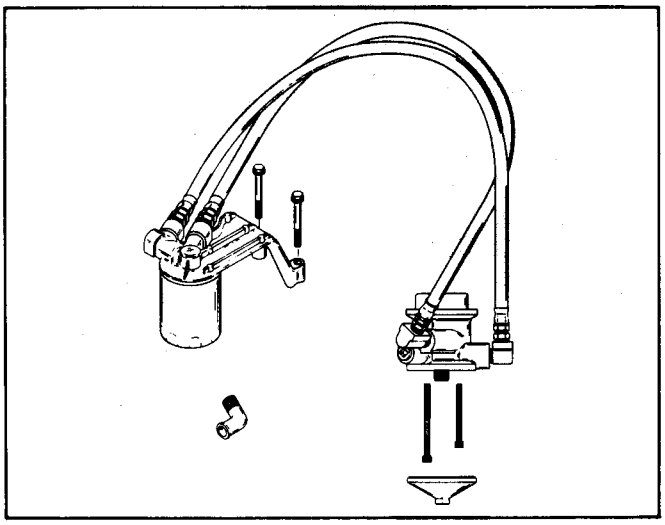
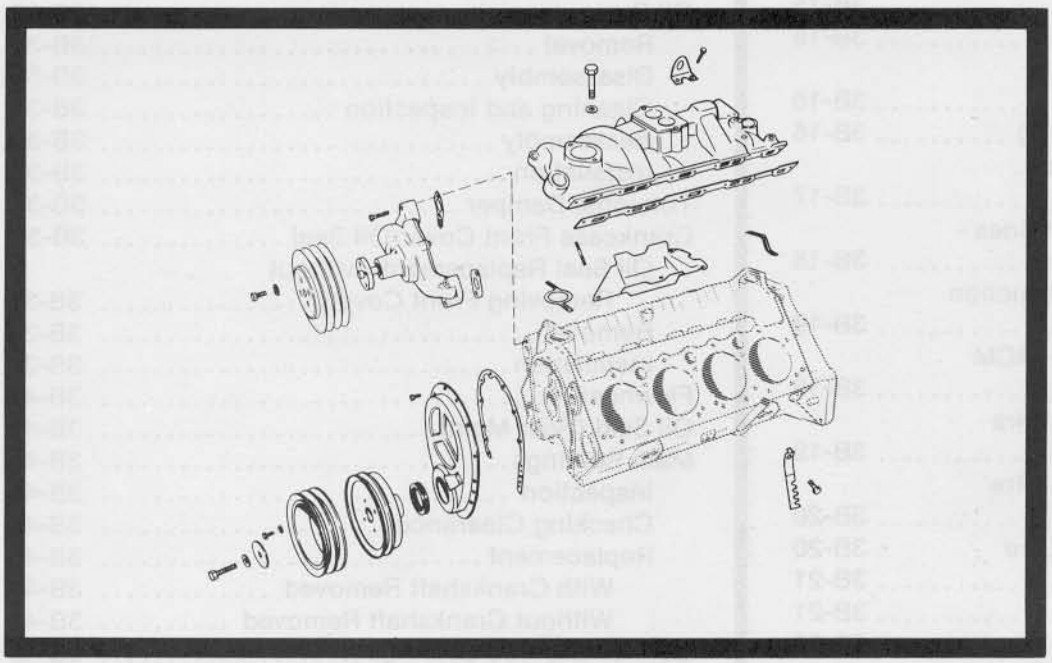




ENGINE



V-8 GM 454/482/540 CID

3

B

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NOTICE

The repair procedures in this manual can be used for repairing Production Performance engines. It is recommended that only mechanics familiar with hi-performance engines attempt the repairs.

Torque Specifications

Fastener Location	454 CID (Standard)		454/482/540 CID Production Performance	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace to Alternator		192 (28)		192 (28)
Alternator Brace to Block	30 (41)		30 (41)	
Alternator to Mounting Bracket	35 (48)		35 (48)	
Alternator Mounting Bracket	30 (41)		30 (41)	
Camshaft Sprocket	25 (34)		25 (34)	
Camshaft Thrust Plate Screws (R.H. Only)		96 (11)		
Carburetor		132 (15)		132 (15)
Connecting Rod Cap	50 (68)			
Connecting Rod Cap (370/400/440/475)			65 (88)	
Connecting Rod Cap (460)			90 (122)	
Crankshaft Damper	85 (115)		85 (115)	
Crankshaft Pulley	35 (48)		35 (48)	
Cylinder Head (Except 482)	80 (109)		80 (109)	
Cylinder Head (482)			75 (102)	
Distributor Hold Down	25 (34)		25 (34)	
Exhaust Manifold	20 (27)			
Exhaust Manifold (Bolts)			35 (48)	
Exhaust Manifold (Nuts)			25 (34)	
Flywheel	65 (88)		70 (95)	
Flywheel Drive Plate	35 (48)		35 (48)	
Flywheel Housing to Block	30 (41)		30 (41)	
Flywheel Housing Cover		80 (9)		80 (9)
Front Mount Bracket	30 (41)		30 (41)	
Fuel Pump	20 (27)		20 (27)	
Intake Manifold	30 (41)		35 (48)	
Main Bearing Cap	110 (149)		110 (149)	
Oil Filter Bypass Valve		80 (9)		80 (9)

Fastener Location	454 CID (Standard)		454/482/540 CID Production Performance	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Oil Pan Plug	20 (27)		20 (27)	
Oil Pan Screw (1/4"-20)		80 (9)		80 (9)
Oil Pan Screw (5/16"-18)		165 (19)		165 (19)
Oil Pump	65 (88)		65 (88)	
Oil Pump Cover		80 (9)		80 (9)
Power Steering Pump Brace to Block	30 (41)		30 (41)	
Power Steering Pump Bracket	30 (41)		30 (41)	
Rear Mount Bolts (MCM)	40 (54)		100 (136)	
Rear Mounts (MIE)	50 (68)		50 (68)	
Remote Oil (1/2"-13)	25 (34)		25 (34)	
Filter Adaptor (5/16"-18)	20 (27)		20 (27)	
Rocker Arm Cover		50 (5.5)		50 (5.5)
Rocker Arm Studs	50 (68)		70 (95)	
Seawater Pump Brace	30 (41)		30 (41)	
Seawater Pump Bracket	30 (41)		30 (41)	
Spark Plugs		180 (20)		180 (20)
Starter Motor	50 (68)		50 (68)	
Thermostat Housing	30 (41)		30 (41)	
Timing Chain or Gear Cover		80 (9)		80 (9)
Transmission to Housing	50 (68)		50 (68)	
Water Circulating Pump	30 (41)		30 (41)	
Water Temp. Sender	20 (27)		20 (27)	

Tools/Lubricants/Sealants

MERCURY MARINE SPECIAL TOOLS	
91-24697	Piston Ring Expanders
91-35547	Engine Coupler Wrench
91-66273	Rocker Stoppers

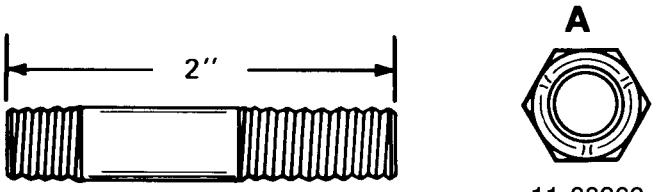
KENT-MOORE SPECIAL TOOLS Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500	
J5892	Valve Spring Compressor
J8062	Valve Spring Compressor
J8056	Valve Spring Tester
J8101	Valve Guide Cleaner
J5830-2	Valve Guide Reamer
J7049-5	Valve Guide Reamer Set
J5802-01	Rocker Arm Stud Remover
J6880	Rocker Arm Stud Installer
J5715	Rocker Arm Stud Hole Reamer (.003" O.S.)
J6036	Rocker Arm Stud Hole Reamer (.013" O.S.)
J8089	Carbon Remover Brush
J24086-100	Piston Pin Tool
J3936-03	Piston Ring Groove Cleaner
J8037	Piston Ring Compressor
J5239	Connecting Rod Bolt Guide Set (3/8" Bolts)
J6098-01	Camshaft Bearing Remover and Installer Tool
J23523-E	Harmonic Balancer Removal and Installer Tool
J22102	Crankcase Front Cover Seal Installer
J21058-20	Crankshaft Gear Installer

Mills Specialty Products 320 E. Jackson St. Freeport, IL 61032 Phone: (815) 235-7946	
CC2778	Cam-Check
6005	Crank Snout Socket
D100	8" Degree Wheel
2416	Dial Indicator

MR Gasket Company 8700 Brookpark Rd. Cleveland, OH 44129 Phone: (216) 398-8300	
85	Off-Set Bushing (Kit)
1591	Timing Tape

LUBRICANTS/SEALANTS	
92-32609-1	Quicksilver Loctite
92-34227	Quicksilver Perfect Seal
92-42649A1	Quicksilver Needle Bearing Assembly Lubricant
92-91601-1	Quicksilver RTV Sealer

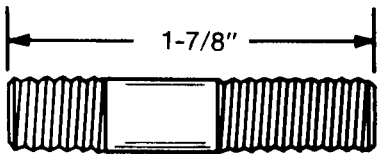
IMPORTANT: DO NOT intermix stud/nut combinations.



16-32808

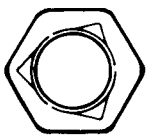
A

11-33962
5/8" Hex ESNA



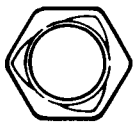
16-98532

B



11/16" Hex
Crownlock

C

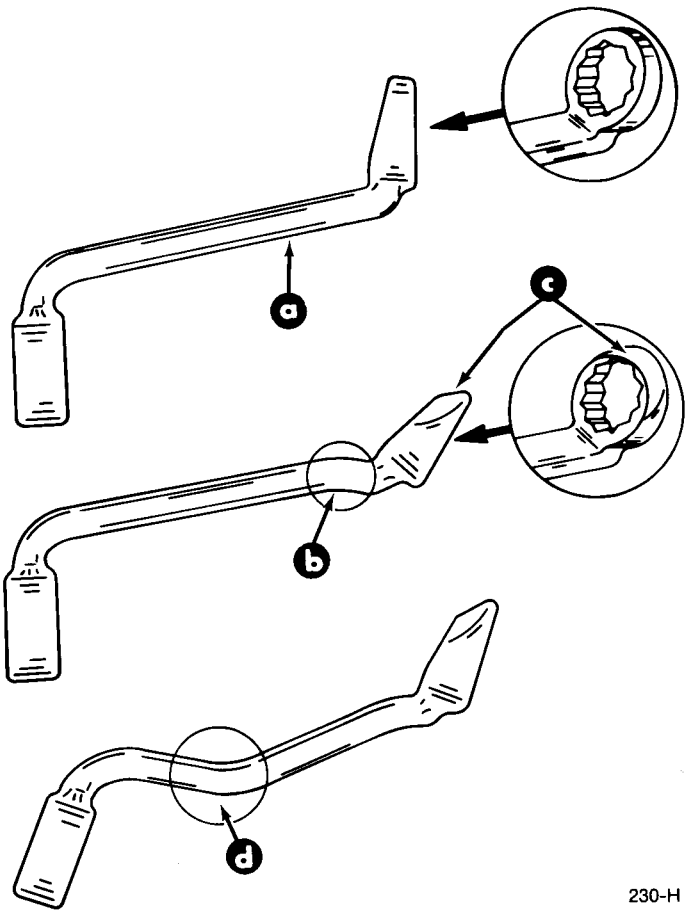


11-98533
5/8" Hex Crownlock

a - 45 Lbs. Ft. (61 N.m)
b - 35 Lbs. Ft. (42 N.m)
c - 40 Lbs. Ft. (54 N.m)
d - See Figure 2 for Coupler Wrench Modification

Figure 1. Engine Coupler/Flywheel

Engine Coupler Wrench, 91-35547, may not work on the later couplers. Modify wrench as shown in Figure 2, so it will work on both earlier and later style couplings.



a - Original 91-35547 Wrench
b - Heat and Bend as Shown
c - Grind Area Shown Slightly
d - Heat and Bend as Shown (This is What Wrench Should Look Like When it's Done)

Figure 2. Modifying Engine Coupler Wrench

Engine Specifications

UNIT OF MEASUREMENT
in (mm)

	330 B/W MCM	454 MCM Magnum Alpha	7.4 Litre	340 MIE	454 Magnum Bravo	MCM 420	400 MCM Cyclone	440 MCM Cyclone	460 MCM Cyclone	575 MCM
Bore	4.25 (107.95)									4.44 (113)
Stroke	4.00 (.101.6)								4.25 (107.95)	4.375 (111)
Cubic Inch Displacement	454 (Standard) (7.5L)				454 (7.5L)				482 (7.9L)	540 (8.9L)
					Production Performance					
Compression Ratio	~~8.1:1~~ 8.5:1				8.6:1	8.8:1			9.2:1	8.75:1
Heads	Cast Iron (Oval Port)				Cast Iron (Rectangle Ports)					
Intake Manifold	Cast Iron				Aluminum Hi-Rise					
Block Note 1	Cast Iron (2 bolt main bearing caps)				Cast Iron (4 bolt main bearing caps)					
Rods	Forged Steel				Forged Steel				Special Forged Steel	
Pistons	Cast Aluminum				Forged Aluminum				Custom Forged Aluminum	
Crankshaft	Cast Iron				Forged Steel				Custom Forged Steel	
Rocker Arms	Stamped Steel				Aluminum Roller					

NOTE 1: Some 1988 standard blocks may have 4 bolt main bearing caps.

Engine	454 CID (Standard)	454 CID	482 CID	540 CID
		Production Performance		

Cylinder Bore:

Diameter			4.2495 - 4.2525 (107.9373 - 108.0135)	4.2451 - 4.2525 (107.8255 - 108.0135)	4.440-4.442 (112.776- 112.826)
Out of Round	Production		.001 (.025) Max.		
	Service		.002 (.05) Max.		
Taper	Production	Thrust Side	.0005 (.0127) Max.		
		Relief Side	.001 (.025) Max.		
	Service		.001 (.025) Max.		.005 (.127)

Piston:

Clearance	Production	.0014 - .0024 (.0356 - .0610)	.0045 - .0065 (.1143 - .1651)	.0055 - .0065 (.1397 - .1651)	.0075 (.1905)
	Service	.0035 (.09) Max.	.0075 (.15) Max.		.0095 (.2413)

Piston Ring:

Compression	Groove Side Clearance	Production	Top	.0017 - .0032 (.04 - .08)		
			2nd	.0017 - .0032 (.04 - .08)		
		Service		Hi Limit Production + .001 (.025)		.0027-.0042 (.06868-.10678)
	Gap	Production	Top	.010 - .020 (.25 - .5)		
			2nd	.010 - .020 (.25 - .5)		
		Service		Hi Limit Production + .010 (.25)		.020-.030 (.508-.762)
Oil	Groove Side Clearance	Production		.005 - .0065 (.127 - .165)		
		Service		Hi Limit Production + .001 (.025)		.0015-.0075 (.0381-.1905)
	Gap	Production		.015 - .055 (.35 - 1.35)	.020 - .035 (.5 - .85)	.015-.055 (.381-1.397)
		Service		Hi Limit Production + .010 (.25)		.025-.065 (.635-1.651)

Piston Pin:

Diameter		.9895 - .9898 (25.1333 - 25.1409)		.990 (25.246)
Clearance	Production	.00025 - .00035 (.00635 - .00889)	.001 - .0015 (.02 - .0366)	.008-.001 (.203-.0254)
	Service	.001 (.02) Max.		.001-.0012 (.0254-.0305)
Fit in Rod (Note 1)		.0008 - .0016 (.0203 - .0406) Interference	.0006 - .001 (.015 - .02)	.0013-.0015 (.0330-.0381)

1. 482/540 CID Production Performance engines have floating piston pins. The pins are secured by two snap rings inserted in grooves in each side of the piston.

Engine (Note 1)	454 CID (Standard)	454 CID	482 CID	540 CID
		Production Performance		

Crankshaft:

Main Journal	Diameter	No. 1	2.7485 - 2.7494 (69.8119 - 69.8348)		2.748-2.749 (69.8195- 69.8246
		No. 2, 3, 4	2.7481 - 2.7490 (69.8017 - 69.8246)		2.748-2.749 (69.8195-69.8246)
		No. 5	2.7478 - 2.7488 (69.7941 - 69.8195)		2.745-2.748 (69.723-69.799)
	Taper	Production	.0002 (.0051) Max.		.0005 (.0127)
		Service	.001 (.025) Max.		.001 (.025)
	Out of Round	Production	.0002 (.0051) Max.		.0005 (0.127)
		Service	.001 (.025) Max.		.001 (.025)
Main Bearing Clearance	Production	No. 1, 2, 3, 4	.0013 - .0025 (.0330 - .0635)	.002 - .0035 (.05 - .08)	.0025-.003 (.0635-.0762)
		No. 5	.0024 - .0040 (.0610 - .1016)	.003 - .004 (.07 - .09)	.0035-.004 (.0889-.1016)
	Service	No. 1	.001 - .0015 (.03)		.0025-.0035 (.0635-.0889)
		No. 2, 3, 4	.001 - .0025 (.03 - .06)		.0025-.0035 (.0635-.0889)
		No. 5	.0025 - .0035 (.07 - .08)		.0035-.0045 (.0889-.1143)
Crankshaft End Play			.006 - .010 (.15 - .25)		.007 - .010 (.1778 - .2540)
Connecting Rod Journal	Diameter		2.1985 - 2.1995 (55.8419 - 55.8673)		2.1980-2.1990 (55.8292-55.8546)
	Taper	Production	.0005 (.0127) Max.		.005(.0127)
		Service	.001 (.025) Max.		.001(.025)
	Out of Round	Production	.0005 (.0127) Max.		.005(.0127)
		Service	.001 (.025) Max.		.001(.025)
Rod Bearing Clearance		Production	.0009 - .0025 (.0229 - .0635)	.0025 - .0035 (.07 - .08)	.0025-.0030 (.0635-.0762)
		Service	.003 (.07) Max.		.0025-.0035 (.0635-.0889)
Rod Side Clearance			.013 - .023 (.35 - .55)	.010 - .020 (.25 - .50)	.025 (.0635)
Crankshaft Runout			.0015 (.0381) Max.		.0005-.0015 (.0127-.0381)

NOTE: 440/460 cyclone and 575 crankshafts are fully polished for added strength and added oil clearance.

Engine CID	454 CID (Standard)		454 CID			482 CID	540 CID
			Production Performance				
Engine Model	MCM 330 (B-W) 7.4 Litre 454 Magnum MIE 340	454 Magnum (Bravo)	MCM 370 ~~MCM 420~~ ~~HP 420~~	410 400 (cyclone) HP420	440 (cyclone)	460 (cyclone)	MCM 575 HP 575

Camshaft and Drive:

Lobe Lift ± .002 (.051)	Intake	.271 (6.883)	.300 (7.62)	.294 (7.468)	.312 (7.925)	.323 (8.204)	.363 (9.227)
	Exhaust	.282 (7.163)	.300 (7.62)	.294 (7.468)	.324 (8.230)	.328 (8.331)	.375 (9.53)
Duration	Intake	350° Note 1	.224° Note 2	356° Note 1	298° Note 2	288° Note 2	292° Note 2
	Exhaust	352° Note 1	.224° Note 2	352° Note 1	306° Note 2	296° Note 2	300° Note 2
Journal Diameter		1.9482 - 1.9492 (49.484 - 49.510)					
Journal Out-of-Round		.001 (.025) Max.					
Camshaft Runout		.002 (.051) Max.					
Timing Chain Deflection [L.H. (Standard) Rotation Engines Only]		3/8 (10) From Taut Position [3/4 (19) Total]					
Camshaft End Play [R.H. (Opposite) Rotation Engines Only]		.001 - .005 (.03 - .1)					
Camshaft Timing Gear Runout [R.H. (Opposite) Rotation Engines Only]		.004 (.102) Max.					
Crankshaft Timing Gear Runout [R.H. (Opposite Rotation Engines Only]		.003 (.076) Max.					
Camshaft to Crankshaft Timing Gear Backlash [R.H. (Opposite) Rotation Engines Only]		.004 - .006 (.102 - .152) New Gears .004 - .008 (.102 - .203) Used Gears					

Cylinder Head:

Gasket Surface Flatness	.003 (.07) in 6 (152) .007 (.15) Overall Maximum

Flywheel

Runout	.009 (.203) Max.

NOTE 1: Duration given is "advertised duration".

NOTE 2: Duration @ .050 (1.27) cam lift.

Engine CID	454 CID (Standard)		454 CID			482 CID	540 CID
			Production Performance				
Engine Model	MCM 330 (B-W) 7.4 Litre 454 Magnum MIE 340	454 Magnum (Bravo)	MCM 370 ~~MCM 420 HP 420~~	420 400 (cyclone) HP420	440 (cyclone)	460 (cyclone)	MCM 575 HP 575

Valve System:

Lifter Type		Hydraulic					Solid
Rocker Arm Ratio		1.70 to 1					
Valve lift	Intake	.461 (11.701)	.510 (12.9)	.500 (12.7)	.530(12.462)	.549 (13.945)	.618 (15.47)
	Exhaust	.479 (12.167)		.500 (12.7)	.551(13.995)	.558 (14.173)	.638 (14.97)
Valve Lash (Intake & Exhaust)		1 Turn from 0 Lash	3/4 Turn from 0 Lash	Roller rocker arms - see page 24			.025 ~~(0 Lash)~~
Face Angle (Intake & Exhaust) (Note 1)		45°					(.635mm)
Seat Angle (Intake & Exhaust)		46°					
Seat Runout (Intake & Exhaust)		.002 (.051) Max.					
Seat Width (Note 1)	Intake	.031 - .062 - (.79 - 1.59)				.065 - .075 (1.66 - 1.90)	.060 (1.59)
	Exhaust	.062 - .093 (1.59 0 2.38)				.075 - .085 (1.90 - 2.16)	.080 (2.0)
Stem Clearance	Intake	.001 - .0027 (.0254 - .0687)					
	Exhaust	.0012 - .0029 (.0305 - .0737)					
Production Service	Intake	.0037 (.0939)					
	Exhaust	.0049 (.1244)					

NOTE 1: 440/460 cyclone and 575 have precise angles ground on the cylinder head and valve and valve for improved flow.

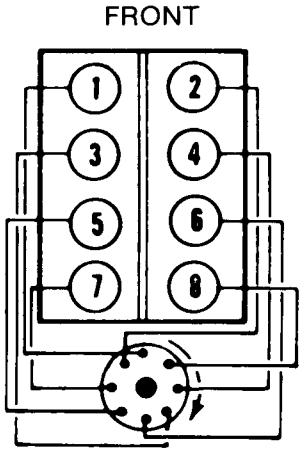
Engine Model				MCM 330 (B-W) 454 Magnum MIE 340 MCM 420 7.4 Litre	MCM 370	400/440 Cyclone Cyclone	MCM 575 460 Cyclone	454 1987 Magnum
				Production Performance				
Valve Spring:								
Valve Spring	Spring 24-75584 (Single Spring)	Free Length		2.12 [1-1/8] (53.8)				
		Pressure (Note 3)	Closed @ 1.88 [1-7/8] (47.75)	74-86 lbs. ft. (100-116 N.m)				
			Open @ 1.38 [1-3/8] (35.05)	288-312 lbs. ft. (390-423 N.m)				
		Installed Height		1.875 [1-7/8] (47.6)				
	Spring Assembly 24-88154 (With 2 Springs)	Free Length			Outer - 2.250 [2-1/4] (57.2) Inner - 2.125 [2-1/8] (54.0)			
		Pressure (Note 2)	Closed @ 1.88 [1-7/8] (47.75)		115-125 lbs. ft. (156-169 N.m)			
			Open @ 1.38 [1-3/8] (35.05)		305-325 lbs. ft. (414-440 N.m)			
		Installed Height			1.875 [1-7/8] (47.6)			
	Spring 24-62074 (No. Paint Stripe)	Free Length				2.210 [2-13/64] (56.1)		
		Pressure (Note 1)	Closed @ 1.875 [1-7/8] (47.63)			115 lbs. ft. (156 N.m)		
			Open @ 1.375 [1-3/8] (34.92)			340 lbs. ft. (461 N.m)		
		Installed Height				1.843 [1-27/3] (46.8)		
	Spring 24-69288 (White and Light Blue Stripe)	Free Length					2.350 [2-11/32] (59.69]	
		Pressure (Note 2)	Closed @ 1.875 [1-7/8] (47.63)				145 lbs. ft. (196 N.m)	
			Open @ 1.375 [1-3/8] (34.92)				360 lbs. ft. (486 N.m)	
		Installed Height					1.906 [1-29/32] (48.4)	
	Spring 24-14754	Free Length						Outer 2.38 (60.5) Inner 2.23 (56.6)
		Pressure (Note 3)	Closed @ 1.875 [1-7/8] (47.63)					60-70 lbs. ft. 81.6 - 95.2 N.m)
			Open @ 1.365 [1-3/8] (34.92)					220-230 lbs. ft. (299.2 - 312 N.m)
		Installed Height						1.875 (47.6)
Damper	Free Length			1.86 [1-55/64] (47.24)				
	Aprroximate No. of Coils			4				

NOTE 1: Test spring pressure with inner and outer springs assembled.
NOTE 2: Test spring pressure with inner and outer springs and damper assembled.
NOTE 3: Test spring pressure with damper removed.

General

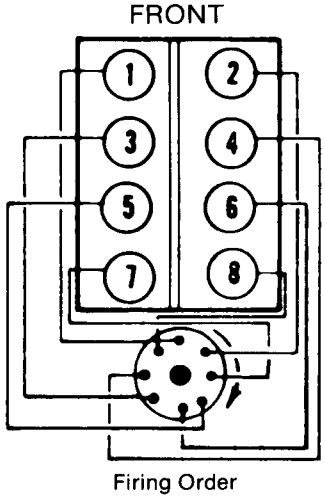
Some repairs, that are listed in this section, must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

Lubricate all moving parts (during reassembly) with engine oil. Apply Perfect Seal on threads of and under head of cylinder head bolts and on threads of all cylinder block external bolts, screws and studs.



Firing Order
1-8-4-3-6-5-7-2

Left-Hand (Standard) Rotation Engine



Firing Order
1-2-7-5-6-3-4-8

Right-Hand (Opposite) Rotation Engine

Engine Identification

The MerCruiser Model can be determined by looking at the LAST TWO LETTERS of the engine code stamped into the cylinder block. This code number is stamped on all MerCruiser Power Packages and replacement partial engines but not replacement cylinder block assemblies.

If the engine serial number, and/or model decals are missing, the engine code letters may help in determining the engine model. Following is a list of G.M. engines and their respective code letters.

MCM Engines (L.H. Rotation)

330 B-W	-XY
454 Magnum Alpha	-XY
454 Magnum Bravo	-XA
7.4 Litre	-WV
370/400/420	
440/460	-XF
Cyclones	

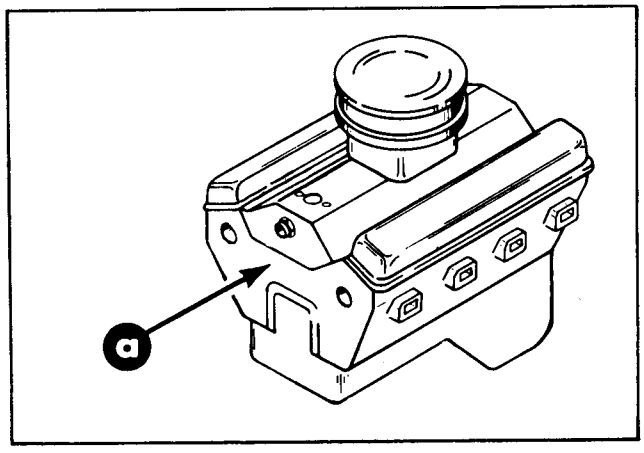
MIE Engines (Either Rotation)

L.H. Rotation

340 - XY OR XYY

R.H. Rotation

340 - XZ or XZZ



a - Large Block V-8 - Front of Engine Just Above Timing Gear/ Chain Cover

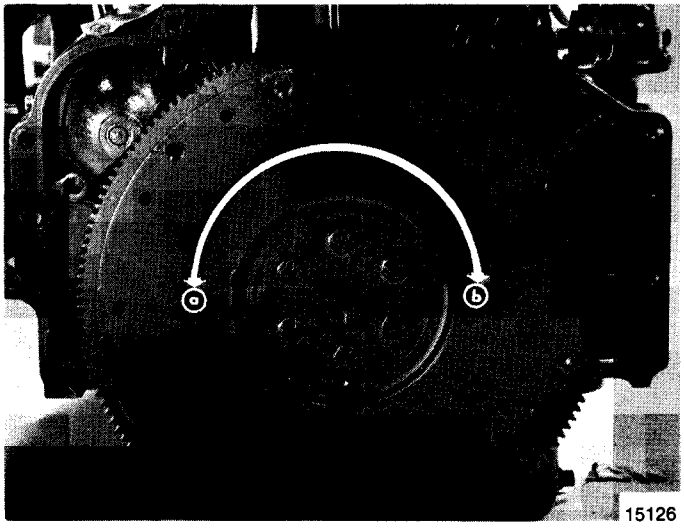
G.M. Engine Code Location

Engine Rotation

Engine rotation terminology at times has caused confusion. To clarify, engine rotation is determined by observing flywheel rotation from the rear (transmission or stern drive end) of the engine looking forward (water pump end).

PROPELLER ROTATION IS NOT NECESSARILY THE SAME as engine rotation.

When ordering replacement engines, short blocks or parts for engines, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



a - Left Hand Rotation (CCW) - All Stern Drive Engines, MIE Inboard L.H. (Standard) Rotation
b - Right Hand Rotation (CW) - MIE Inboard R.H. (Opposite) Rotation

Crankshaft

The crankshaft is supported in the block by five insert type bearings. Crankshaft end thrust is controlled by flanges on the number five bearing. A torsional damper on the forward end of the crankshaft serves to help dampen any engine torsional vibration.

Piston and Connecting Rods

Piston pins are offset slightly toward the thrust side of the pistons to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins have a floating fit in the piston and a press fit in the connecting rod (to hold them in place).

Connecting rods are made of forged steel and are connected to the crankshaft thru insert type bearings.

Camshaft and Drive

Camshaft is supported by five bearings, which are pressed into the block, and is driven at one-half crankshaft speed by a timing chain and sprockets or by timing gears.

Taper on lobes coupled with spherical foot on hydraulic valve lifters, causes the valve lifters to rotate, thus reducing wear. A helical gear on the aft end of the camshaft drives the distributor and oil pump, while an eccentric cam on the front of the camshaft actuates the fuel pump.

Cylinder Head

The cylinder heads are made of cast iron and have individual intake and exhaust ports for each cylinder.

Stainless steel or composition head gaskets are used to retard corrosion.

Valve Train

The valves and valve springs are of a heavy-duty design to withstand the high engine speeds encountered. Valve tips have been hardened to extend valve life. Exhaust valve rotators are used on all engines except the (production-performance 454 CID engines) to help extend valve life.

Hydraulic valve lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the push rods which in turn actuate the valves thru the rocker arm.

In addition to transmitting thrust of the cam lobes, the hydraulic lifters also serves to remove any clearance (lash) from the valve train to keep all parts in constant contact.

The valve lifters also are used to lubricate the valve train bearing surfaces.

Intake Manifold

The manifold is of the double level design for efficient fuel distribution. The upper level of passages feeds cylinders 2, 3, 5 and 8 while the lower level passages feed cylinders 1, 4, 6 and 7. All passages are of approximately equal length to assure more even fuel-air mixture to the cylinders.

Lubrication System

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft, connecting rods, camshaft bearings and valve lifters, and is supplied under controlled volume to the push rods and rocker arms. All other moving parts are lubricated by gravity flow or splash.

A positive displacement gear-type oil pump is mounted on the rear main bearing cap and is driven by an extension shaft from the distributor (which is driven by the camshaft). Oil from the bottom of the pump in the rear of the oil pan is drawn into the oil pump through an oil pickup screen and pipe assembly.

If screen should become clogged, a relief valve in the screen will open and continue to allow oil to be drawn into system. Once the oil reaches the pump, the pump forces the oil thru the lubrication system. A spring loaded relief valve in the pump limits the maximum pump output pressure.

After leaving the pump, the pressurized oil flows thru a full-flow oil filter. On engines with an engine oil cooler, the oil also flows thru the cooler before returning to the block. A bypass valve (on all engines except production-performance 454 CID) allows oil to bypass the filter and oil cooler should they become restricted. A bypass valve is not used on hi-performance 454 CID engines to ensure that all of the oil is filtered.

Some of the oil, after leaving the oil cooler and/or filter, is routed to the main oil gallery, on the left side of the cylinder block, which supplies oil thru individual passages to the No. 1, 2, 3 and 4 crankshaft main bearings and the No. 1, 2, 3 and 4 camshaft bearings. The remainder of the oil is routed to the No. 5 crankshaft main bearing and to an annular groove in the No. 5 camshaft bearing bore. Some of the oil is then used to lubricate the camshaft bearing, while the remainder is routed to both valve lifter oil galleries thru oil passages which intersect the annular groove.

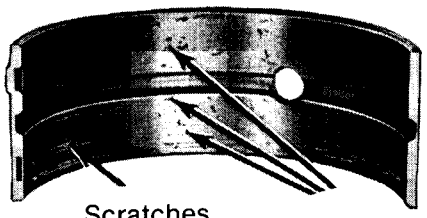
The camshaft bearings have holes which align with the oil passages or annular grooves in the block and allow oil to flow in between the bearings and the camshaft journals. The oil that is forced out the front end of the No. 1 camshaft bearing drains down onto camshaft drive and keeps it lubricated.

The oil which reaches the crankshaft main bearings is forced thru a hole in the upper half of each bearing and flows in-between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings thru grooves in the upper half of the crankshaft main bearings and oil passages in crankshaft. Oil which is forced out the ends of the connecting rod bearings and crankshaft main bearings is splashed onto the camshaft, cylinder walls, pistons and piston pins, keeping them lubricated. Oil which is forced out the front end of the No. 1 crankshaft main bearing also assists in lubricating the camshaft drive. A baffle plate, mounted on the bottom of the main bearings or in the oil pan, prevents oil thrown from the crankshaft and connecting rods from areating the oil in the oil pan.

Oil which reaches the valve lifters oil galleries is forced into each hydraulic valve lifter thru holes in the side of the lifter. From here, the oil is forced thru the metering valve in each of the lifters (which controls the volume of oil flow) and then up thru the push rods to the rocker arms. A hole in each rocker arm push rod seat allows the oil to pass thru the rocker arm and lubricate the valve train bearing surfaces. After lubricating valve train, oil drains back to the oil pan thru oil returns holes in the cylinder head and block.

The distributor shaft and gear also is lubricated by the oil flowing thru the right valve lifter oil gallery. Fuel pump push rod is lubricated by oil thrown off from the camshaft eccentric.

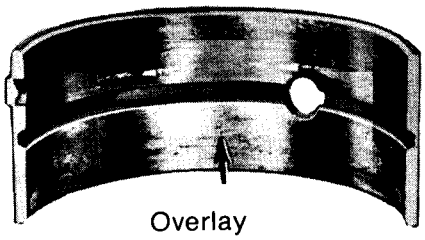
Bearing Failures



Scratches

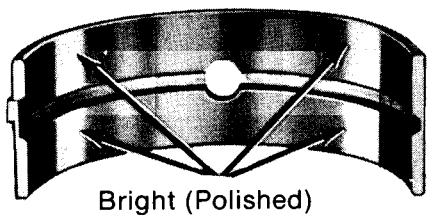
Dirt Imbedded into Bearing Material

SCRATCHED BY DIRT



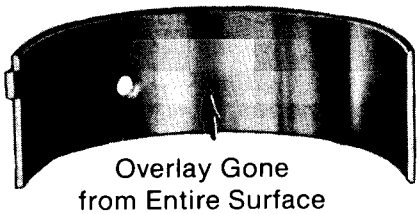
Overlay Wiped Out

LACK OF OIL



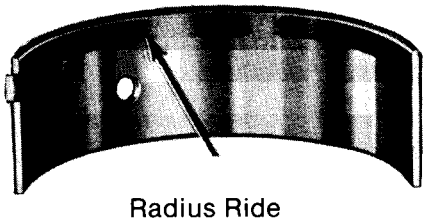
Bright (Polished) Sections

IMPROPER SEATING



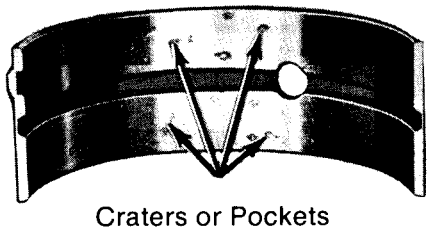
Overlay Gone from Entire Surface

TAPERED JOURNAL



Radius Ride

RADIUS RIDE



Craters or Pockets

FATIGUE FAILURE

Piston Failures

Pre-Ignition

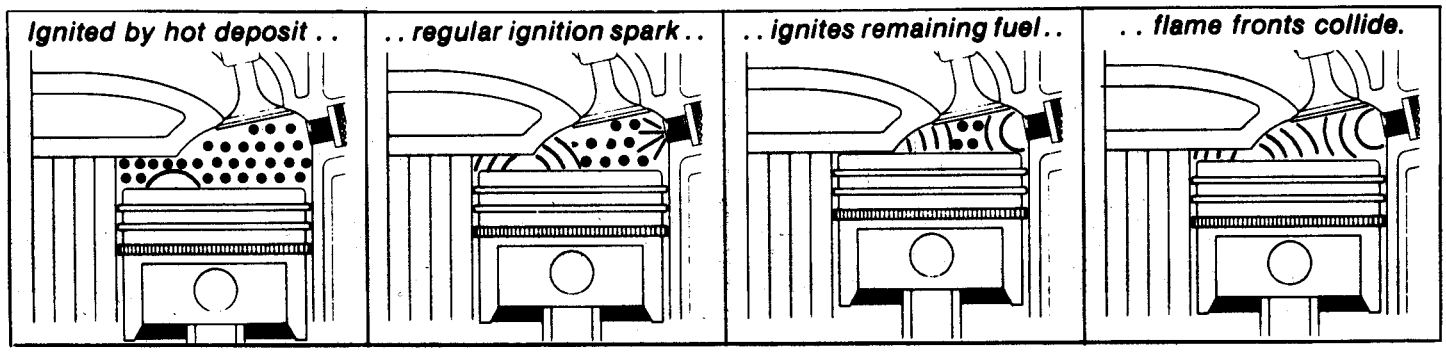
Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion of the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.

Pre-Ignition Damage

Pre-Ignition Causes

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.

Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine, therefore, no warranty will apply to failures which occur under these conditions.



Detonation

Detonation, commonly called "fuel knock", "spark knock" or "carbon knock", is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.

Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

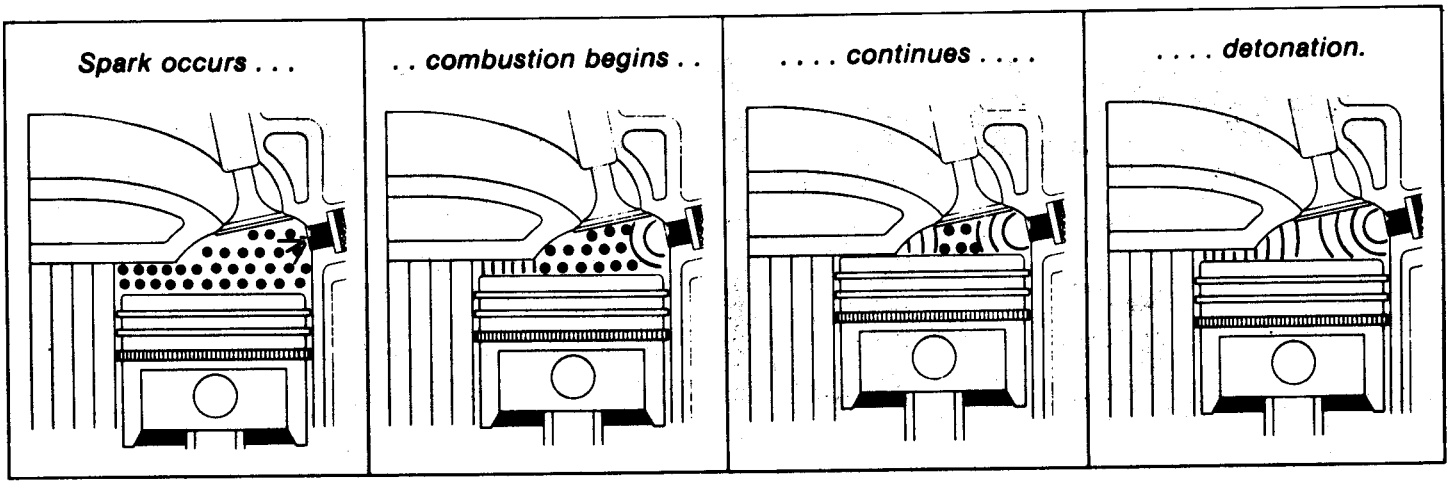
OTHER CAUSES of DETONATION

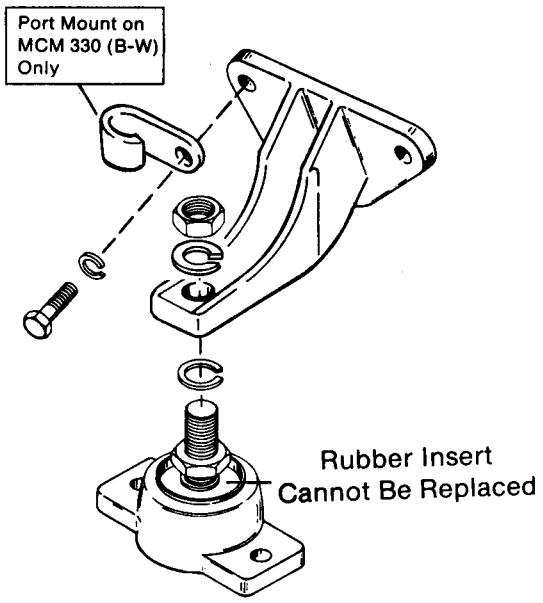
IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).
5. Inadequate cooling of engine by deterioration of cooling system.

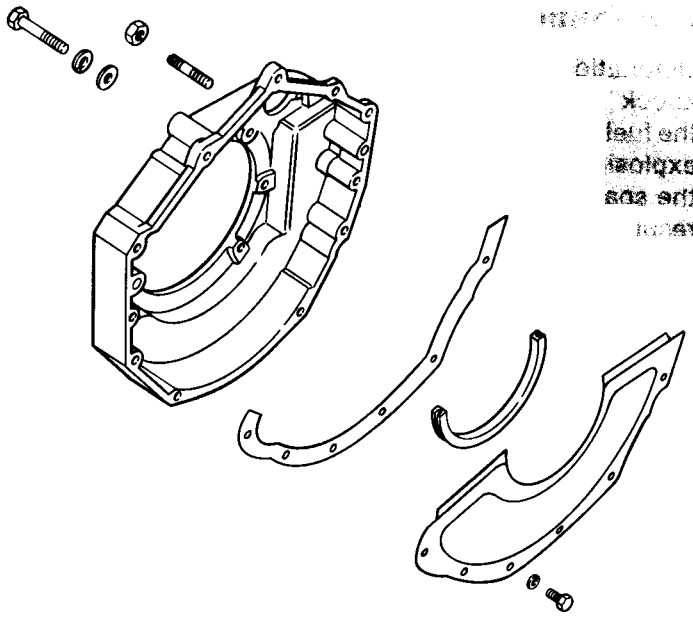
Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine, therefore, no warranty will apply to failures which occur under these conditions.

Detonation Damage

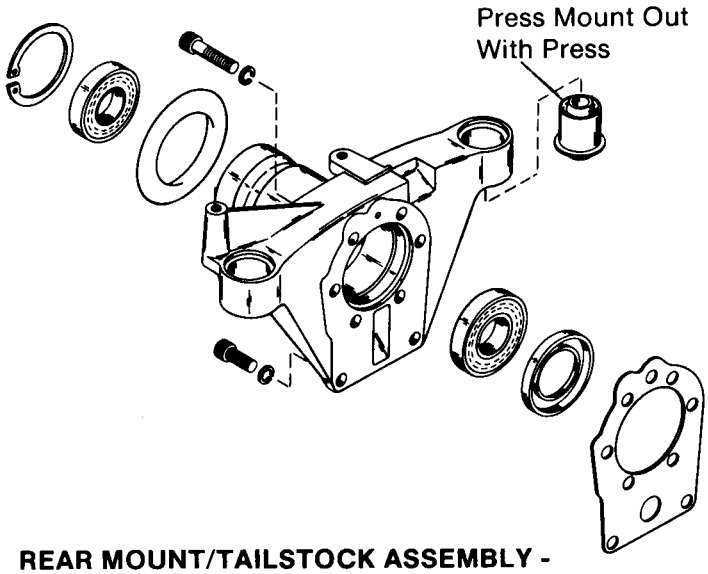




FRONT MOUNT - MCM (B-W)



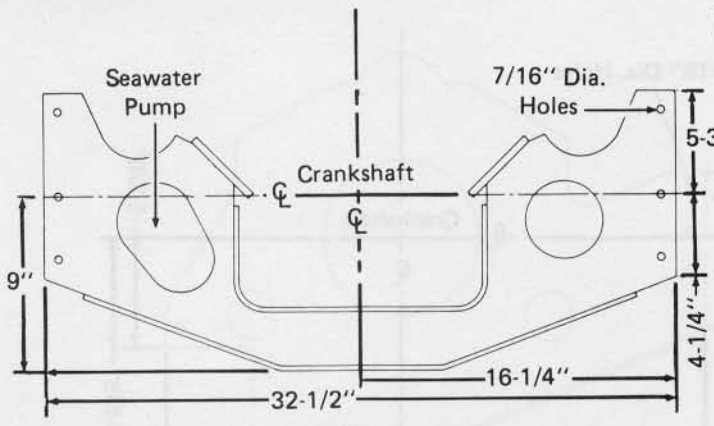
FLYWHEEL HOUSING - MCM 330 (B-W)



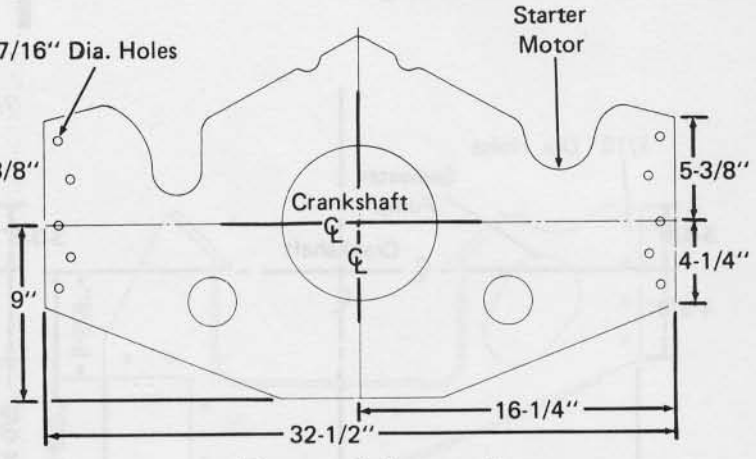
REAR MOUNT/TAILSTOCK ASSEMBLY - MCM 330 (B-W)

NOTE: View of mount is from front of engine, looking toward transom.

MOUNTING PLATES -
Production Performance Engines

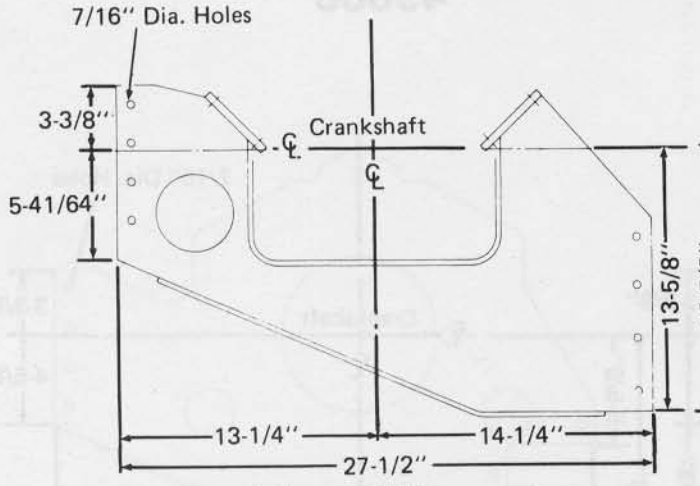


Front Mount
49863

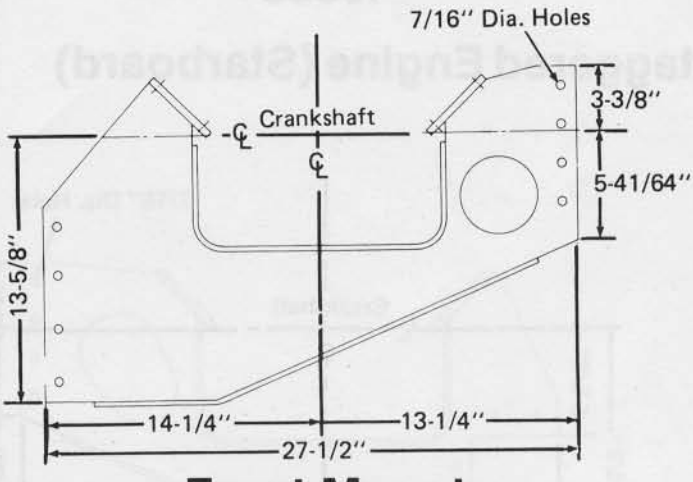


Rear Mount
49864

Single Engines



Front Mount
Starboard Engine
72515

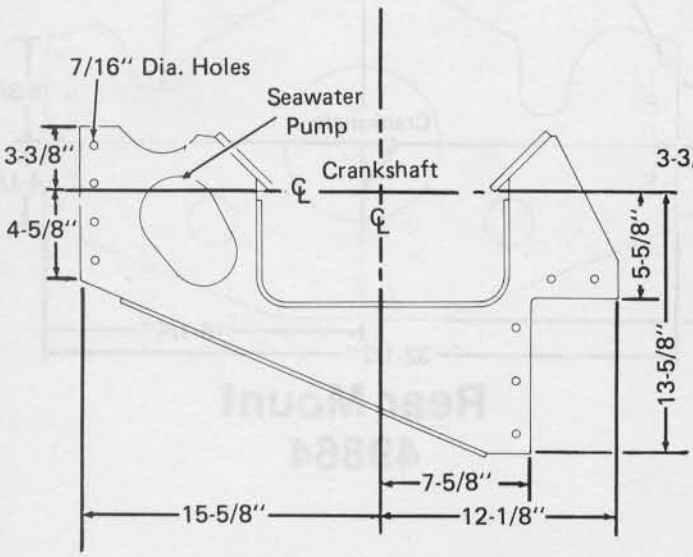


Front Mount
Port Engine
72514

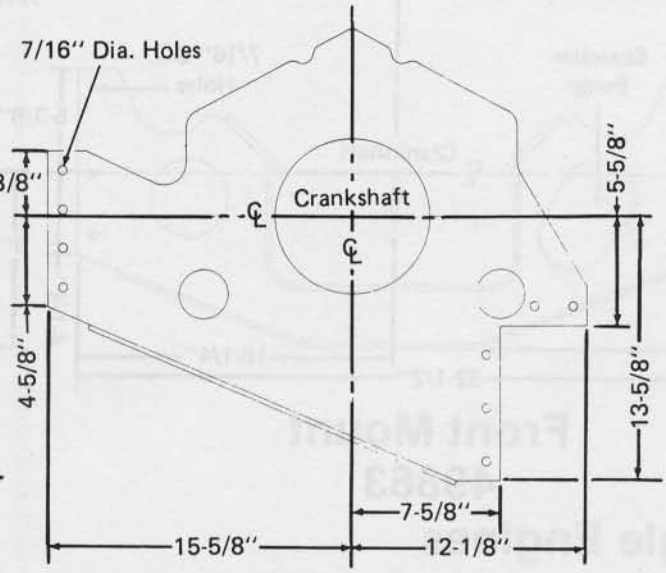
Side by Side Engines

NOTE: View of mount is from front of engine, looking toward transom.

MOUNTING PLATES FOR STAGGERED ENGINES - Production Performance Engines

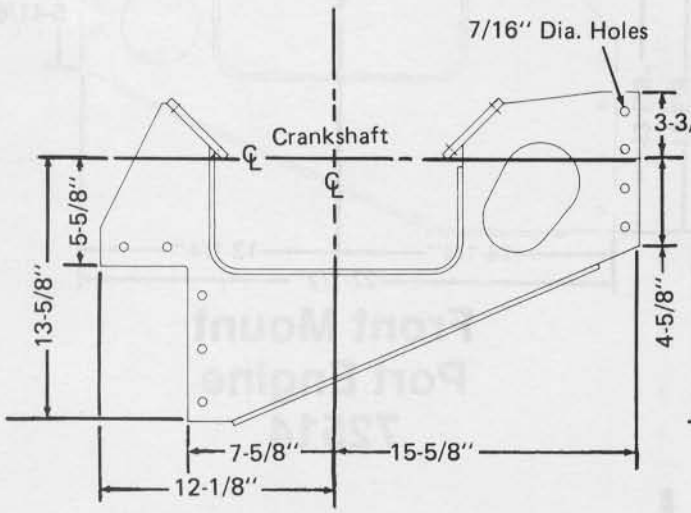


Front Mount 49865

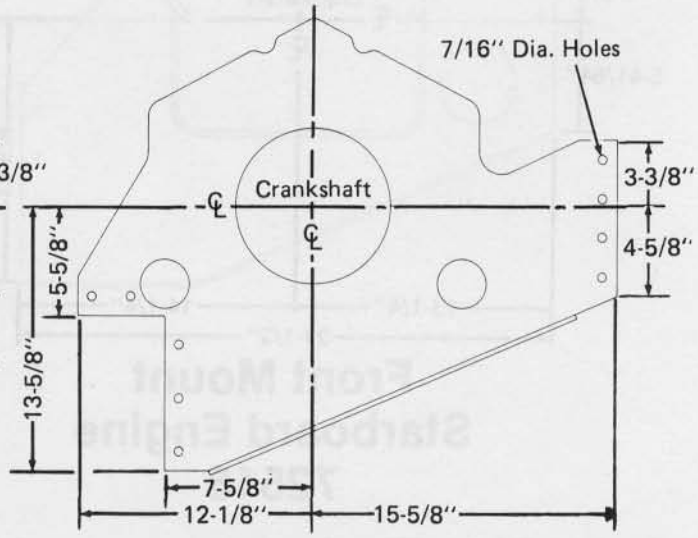


Rear Mount 49866

Staggered Engine (Starboard)

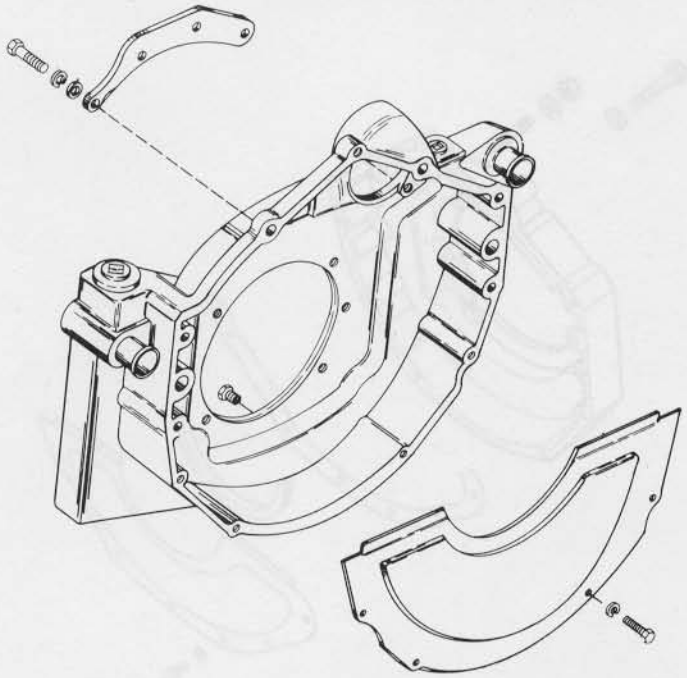


Front Mount 88665

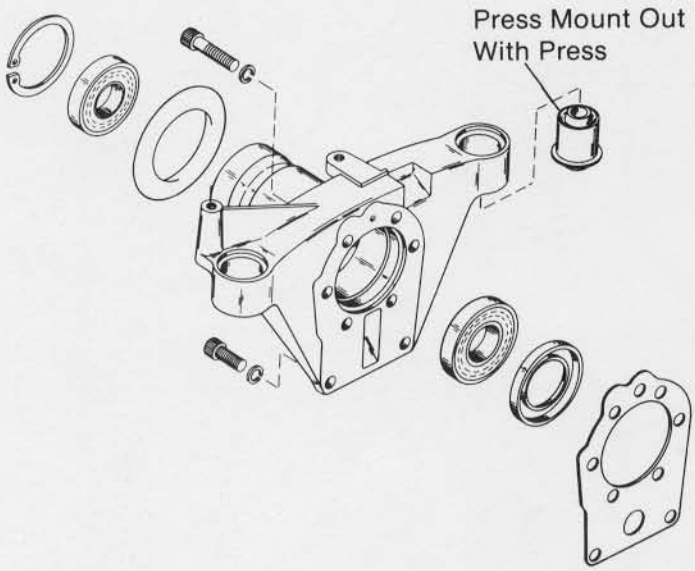


Rear Mount 49866

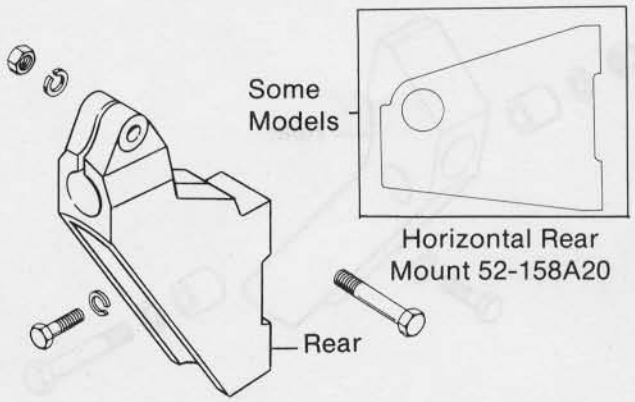
Staggered Engine (Port)



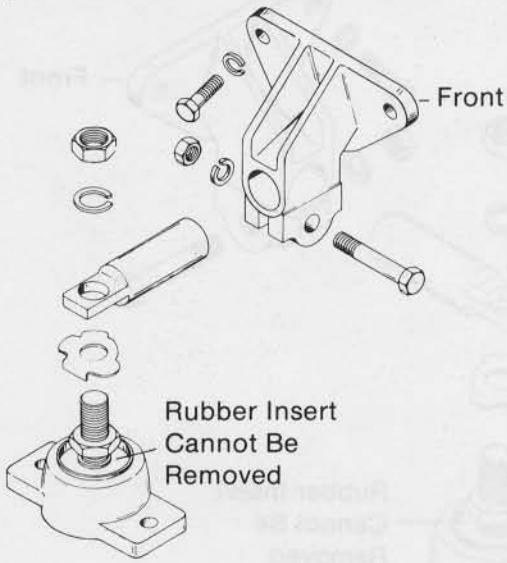
FLYWHEEL HOUSING -
Production Performance Engines



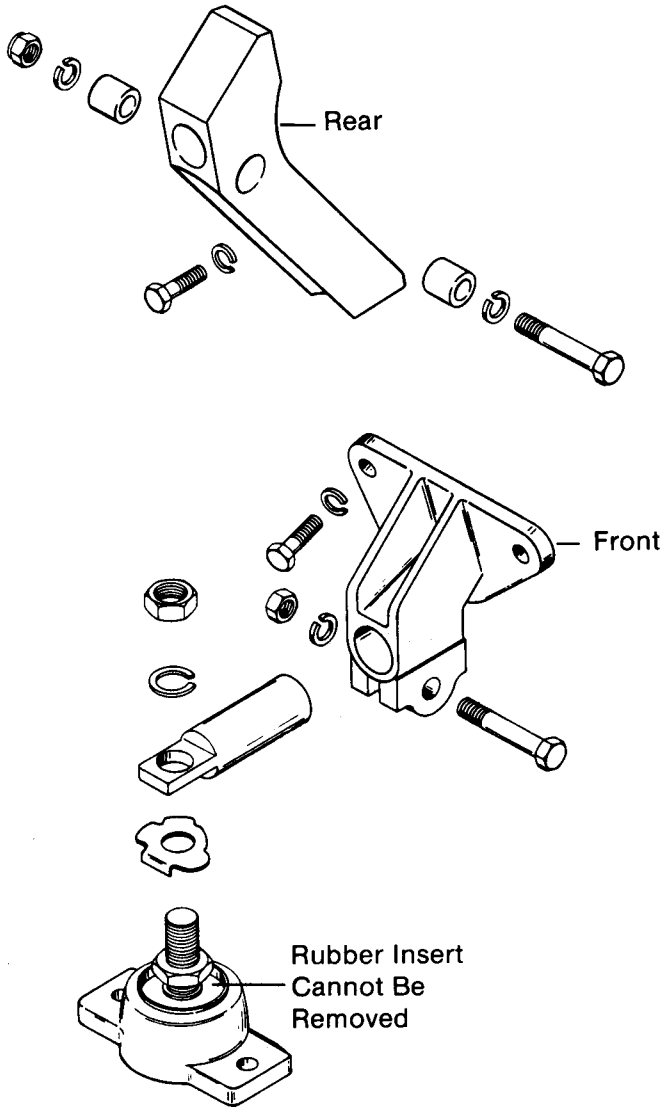
REAR MOUNT/TAILSOCK ASSEMBLY -
Production - Performance Engines (Some Models)



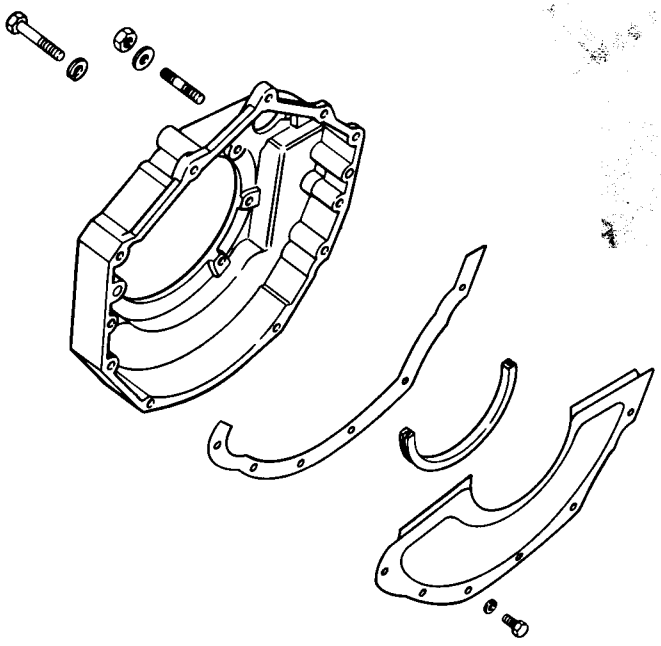
NOTE: Center of lower mounting hole is 1/2" (13mm) up from bottom of casting.



FRONT/REAR MOUNTS -
MIE 340/7.4 Litre In-Line Transmission Engines



FRONT/REAR MOUNTS -
MIE 340/7.4 Litre V-Drive Engines



FLYWHEEL HOUSING - MIE 340/7.4 Litre Engines

Rocker Arm Cover

Removal

On engines with Center Exhaust Outlet exhaust manifolds: It may be necessary to remove exhaust manifold before removing rocker arm cover. Also remove any component that will interfere with the removal of the manifold or rocker arm cover.

1. Remove rocker arm cover attaching hardware.
2. Disconnect crankcase ventilation hoses.

IMPORTANT: Do not pry rocker arm cover loose. Gaskets, which adhere to cylinder head and rocker arm cover, may be sheared by bumping end of rocker arm cover from the rear with palm of hand or a rubber mallet.

3. Remove rocker arm cover.

Installation

1. Clean sealing surfaces on cylinder head and rocker arm cover with degreaser.
2. Install rocker arm covers, as follows:

ROCKER ARM COVERS USING GASKETS:

a. Place new rocker arm cover gasket in position in rocker arm cover.

b. Install rocker arm cover and secure with reinforcements and attaching screws or nuts. Torque to specifications.

Rocker Arm Covers Using RTV Sealer:

a. Apply a 3/16" (5mm) wide bead of RTV Sealer all-the-way around sealing surface on cylinder head, making sure to apply sealer on inboard side of attaching screw holes or studs.

IMPORTANT: Be sure to install valve rocker arm cover while sealer is still wet. Sealer dries in approximately 15 minutes.

b. Install rocker arm cover and secure with attaching screws or nuts. Torque to specifications.

3. Reinstall exhaust manifolds, if removed.
4. Reinstall any items which were removed from exhaust elbows to allow removal of rocker arm covers.
5. Connect crankcase ventilation hoses to valve rocker arm covers.
6. Start engine and check for oil leaks.

Intake Manifold

Removal

1. Drain engine cooling system.
2. Disconnect hoses from thermostat housing.

   Disconnect intake manifold to circulating pump bypass hose from circulating pump.
3. Disconnect wire from water temperature sending unit. On some 454 cu. in. engines, it may be necessary to remove sending unit to allow removal of manifold attaching screw.
4. Disconnect crankcase ventilation hoses from rocker arm covers.
5. Disconnect throttle cable from carburetor. Remove fuel line running between fuel pump and carburetor.

IMPORTANT: Do not crank engine over after distributor has been removed.

6. Remove distributor cap and mark position of rotor on distributor housing. Also, mark position of distributor housing on intake manifold. Remove distributor.
7. Remove other ignition components.
8. Disconnect any other items that will prevent removal of manifold.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block, in next step. Use extreme care to prevent damage to sealing surfaces.

9. Remove intake manifold screws, then remove intake manifold and carburetor assembly.

NOTE: If intake manifold requires replacement, transfer carburetor and other related parts to new manifold.

Cleaning and Inspection

1. Clean gasket material from all mating surfaces.

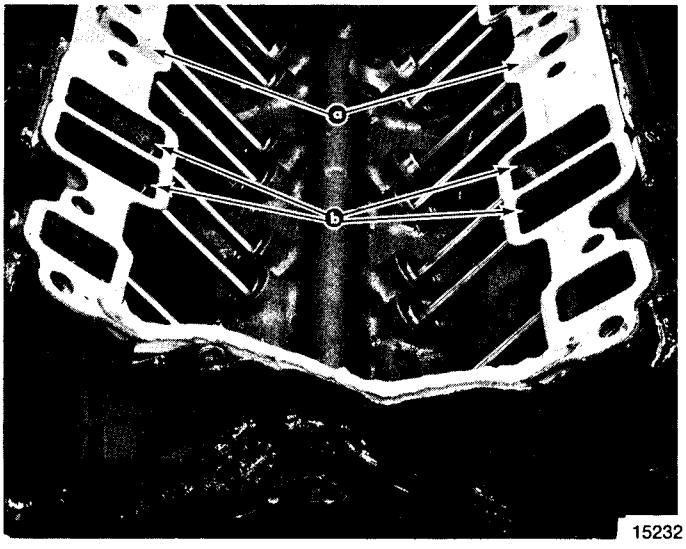
IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase.

2. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks, or deep scratches or leaks may result.
3. Check intake passages for varnish buildup or other foreign material. Clean as necessary.

Installation

IMPORTANT: When installing intake manifold gaskets, in next step, be sure to do the following:

- **Be sure to install gasket marked "Right Side Only" on the starboard (right) cylinder head and unmarked gasket on the port (left) cylinder head.**
- **All MerCruiser V-8 G.M engines that have "automatic" carburetor chokes must use an intake gasket that has an opening for the exhaust crossover port in the intake manifold. Without this opening the "automatic" carburetor choke will not operate properly. The choke will remain "On" longer causing rough engine operation and wasted fuel.**



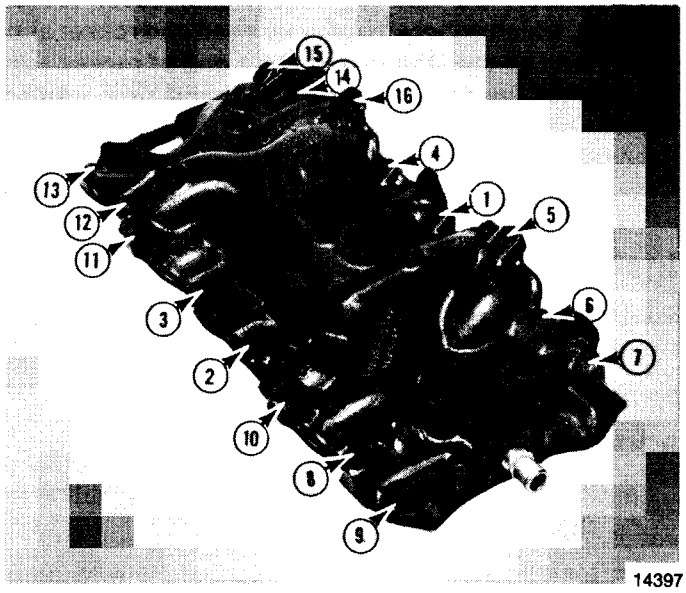
15232

a - Exhaust Crossover Port Opening in Gasket
b - Intake Valve Ports

1. Apply Perfect Seal to intake manifold gaskets and install gaskets on cylinder heads. Install front and rear end seals on cylinder block and apply Perfect Seal to areas where seals butt against gaskets.

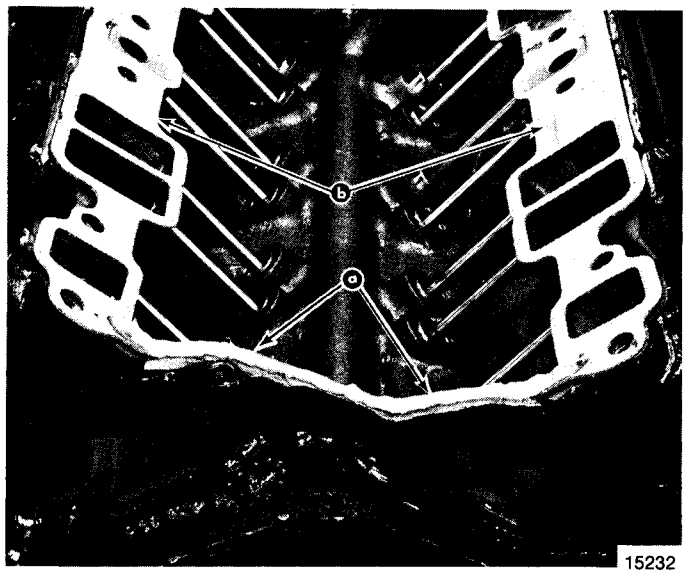
IMPORTANT: If cylinder block rails do not have holes for locating pins on end seals, RTV Sealer must be used instead of seals. Place a 3/16" (5mm) wide bead of RTV Sealer. Extend the bead 1/2" (13mm) up each gasket to seal and retain gaskets. RTV Sealer can be used instead of end seals on all engines, if desired.

2. Carefully install manifold assembly and torque bolts to specifications in sequence outlined.



14397

3. Connect intake manifold to circulating pump bypass hose.
4. Connect wire to water temperature sending unit.
5. Reconnect hoses to thermostat housing.
6. Install fuel line to carburetor and fuel pump. Connect throttle cable to carburetor.
7. Connect crankcase ventilation hoses to rocker arm covers.
8. Install distributor. Position rotor and housing to align with marks made during removal, then install distributor cap.
9. Install other ignition components and reconnect wires.
10. Reconnect any other items which were disconnected from manifold during the removal.
11. Start engine. Adjust ignition timing and carburetor. Check hose connections, gaskets and seals for leaks.
12. Inspect fuel line connections for fuel leaks.



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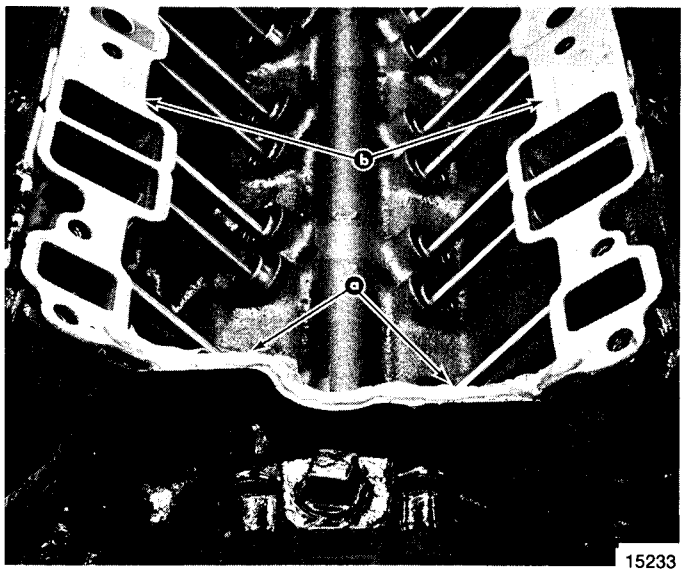


15233

a - RTV Sealer
b - Intake Manifold Gaskets

Rocker Arm/Push Rod

Removal

1. Remove rocker arm covers.
2. Remove rocker arm components, rocker arms and push rods.

IMPORTANT: Place rocker arms, rocker arm components and push rods in a rack for reinstallation in the same locations.

Cleaning and Inspection

1. Clean parts with solvent and dry with compressed air.
2. Inspect all contact surfaces for wear. Replace all damaged parts.

Installation

454 CID (Without Roller Rocker Arms) Engines

IMPORTANT: Push rods with a hardened tip end must be installed with the hardened tip toward rocker arm. Push rods without hardened tip must be installed with large oil hole end toward rocker arms. Hardened tip end or large hole end is marked with a blue stripe.

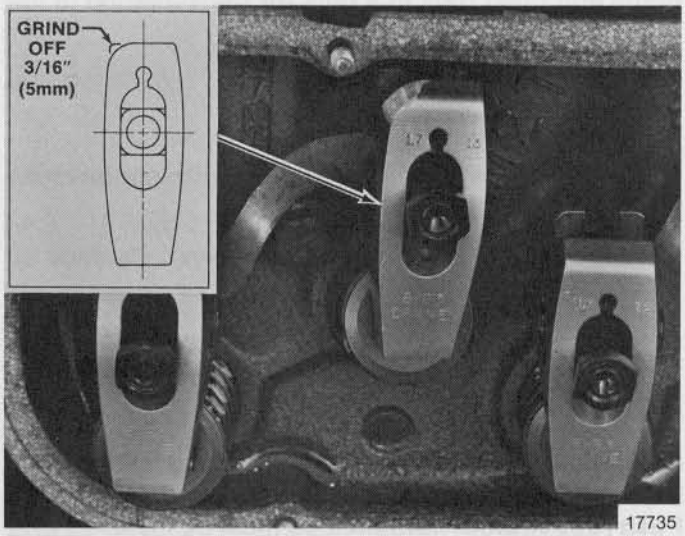
IMPORTANT: When installing rocker arms and rocker arm balls, coat bearing surfaces of rocker arms and rock arm balls with engine oil.

1. Install push rods. Be sure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts. Tighten rocker arm nuts until all lash is eliminated.
3. Valve lash can be adjusted either with engine stopped or running.

Production Performance Engines (With Roller Rocker Arms)

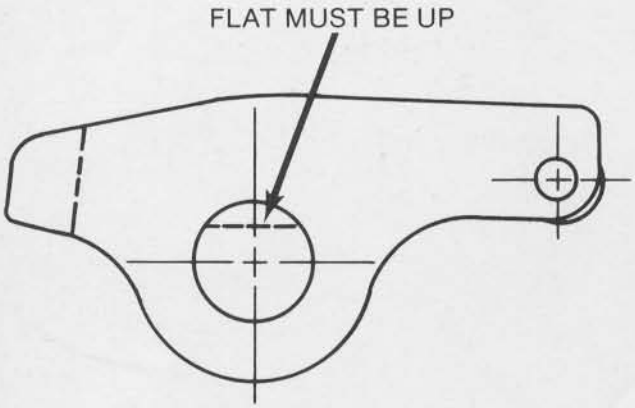
IMPORTANT: No. 1 and No. 8 intake rocker arm have 3/16" (5mm) removed from left hand corner of arm to clear valve cover. If new rocker arm is used, modify as shown.

IMPORTANT: When installing rocker arms and push rods, lubricate with engine oil.



No. 1 and No. 8 Intake Rocker Arm

1. Install push rods (long-exhaust, short-intake). Be sure push rods seat in lifter socket.
2. Install new rocker arms making sure that flat side of pivot shaft is facing up. Lubricate ends of rocker arm studs and valve stem ends with Needle Bearing Lubricant (92-42649A1). Install locking nuts on studs.
3. Valve adjustment must be done with engine stopped.

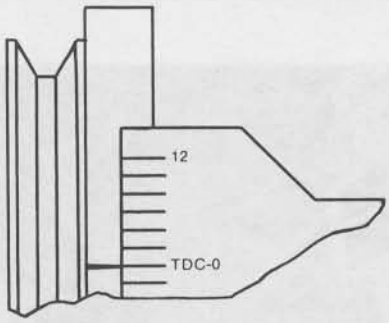


Adjustment - Engine Stopped

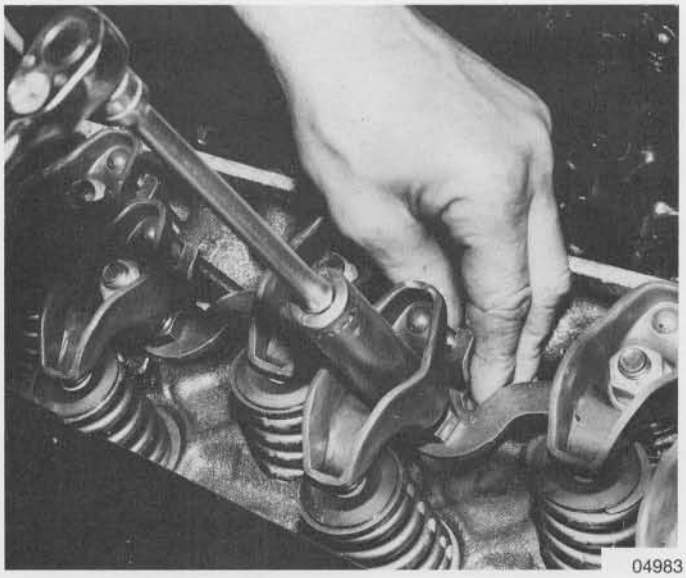
454 CID (without Roller Rocker Arm) Engines

With valve cover removed, adjust valves when lifter is on low part of camshaft lobe, as follows:

1. Crank engine with starter or turn over in normal direction of rotation until mark on torsional damper lines up with center "O" mark on timing tab, and engine is in No. 1 firing position. This may be determined by placing fingers on No. 1 valve as mark on damper comes near "O" mark on timing mark. If valves move as mark comes up to timing tab, engine is in No. 6 firing position and should be turned over one more time to reach No. 1 position.
2. With engine in No. 1 firing position as determined above, the following valves may be adjusted.



3. **MCM and MIE Left Hand (Standard) Rotation Engines:**
   Exhaust - 1-3-4-8 Intake - 1-2-5-7
   MIE Right Hand (Opposite) Rotation Engines:
   Exhaust - 1-2-5-7 Intake - 1-3-4-8
4. Back out adjusting nut until lash is felt at push rod, then turn in adjusting nut until all lash is removed. This can be determined by moving push rod up-and-down while turning adjusting nut until all play is removed.



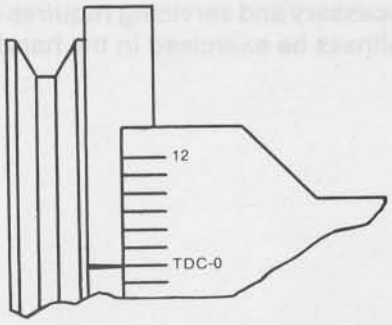
Valve Adjustment

5. Hydraulic lifters now can be adjusted by tightening adjustment nut an additional 1-turn. No other adjustment is required.
6. Crank engine one revolution until pointer "O" mark and torsional damper mark are again in alignment. This is No. 6 firing position. With engine in this position, the following valves may be adjusted as previously outlined.
7. **MCM and MIE Left Hand (Standard) Rotation Engines:**
   Exhaust - 2-5-6-7 Intake - 3-4-6-8
   MIE Right Hand (Opposite) Rotation Engines:
   Exhaust - 3-4-6-8 Intake - 2-5-6-7

Production Performance Engines (with Roller Rocker Arms)

Valves must be adjusted when hydraulic lifter is on low part of camshaft.

1. Rotate engine (in normal direction of rotation) until timing mark on crankshaft balancer lines up with "0" (TDC) mark on timing tab and engine is in No. 1 firing position. This may be determined by placing fingers on No. 1 push rods as mark on balancer comes near the "0" (TDC) mark. If push rods move as timing mark comes up on "0", engine is in No. 6 firing position. Rotate crankshaft one more complete revolution to reach No. 1 firing position.



2. With engine crankshaft positioned as outlined, adjust valves on the following cylinders:

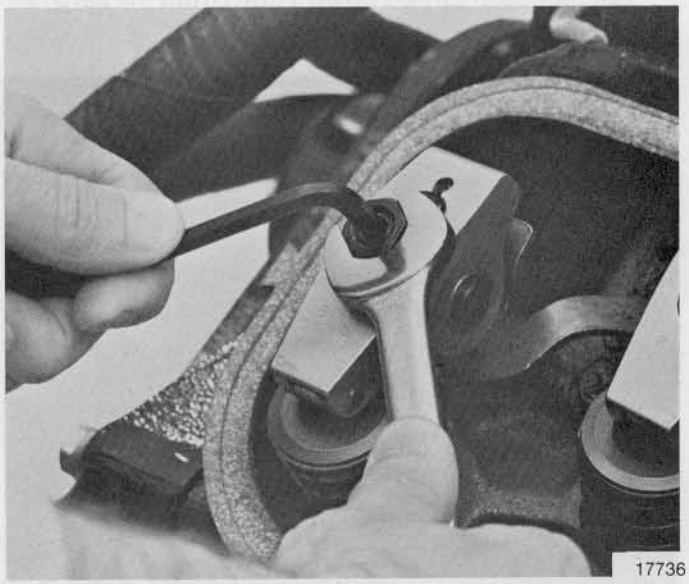
   Exhaust 1-3-4-8 Intake 1-2-5-7

IMPORTANT: Make sure push rods are centered in sockets of rocker arm before tightening. This must be done for each valve.

3. Obtaining correct valve lash as follows;
   Hydraulic lifters: turn 9/16" locking nut down on rocker arm until there is zero clearance between rocker arm and valve stem. Turn locking nut an additional 1/2 turn and snug allen screw onto top of rocker arm stud. Do not let locking nut turn. Remove allen wrench and box wrench and torque locking nut to 30 lbs. ft. (41 N.m).
   Solid lifters: loosen 9/16" locknut until a feeler gauge the correct thickness (Tune Up Specifications) can be slide between the rocker arm and valve stem. Tighten the 9/16" locking nut until there is a snug drag on feeler gauge when removing from between rocker arm and valve stem. Hold 9/16" locking nut in position and torque allen set screw to 20 lbs. ft. (28 N.m)
4. Rotate crankshaft one complete (360°) revolution until timing mark on balancer is aligned with "O" mark on timing tab. Adjust valves on the following cylinders:

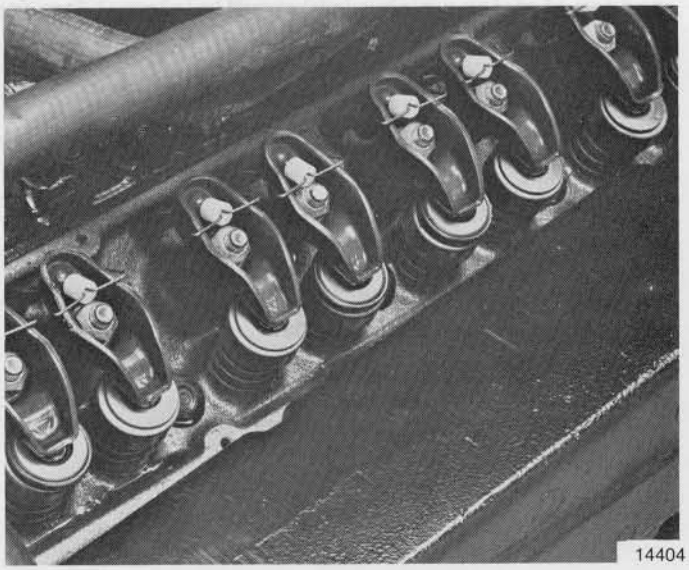
   Exhaust 2-5-6-7 Intake 3-4-6-8

5. Adjust remaining rocker arms as outlined in Step 3.



Rocker Stoppers 91-66273

Adjustment - Engine Running (Hydraulic Lifters Only)

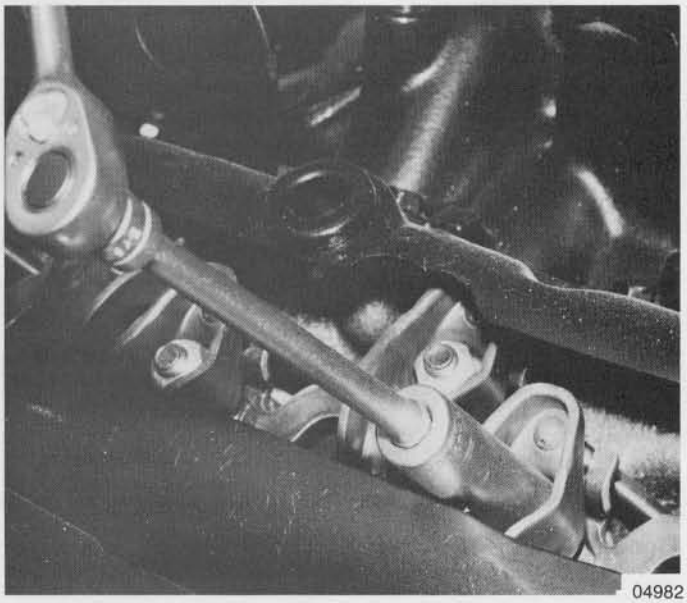


Valve Adjustment

454 CID (without Roller Rocker Arms) Engines

Following procedure is performed with engine running:

1. After engine has been rechecked for normal operating temperature, remove valve covers and install rocker stoppers.
2. With engine running at idle, back valve rocker arm nuts off (one at a time) until valve rocker arm starts to clatter.
3. Turn rocker arm nut down until clatter just stops. This is zero lash position.
4. Turn nut down 1/4 additional turn and pause 10 seconds until engine runs smoothly. Repeat until nut has been turned down 1-turn from the zero lash position.

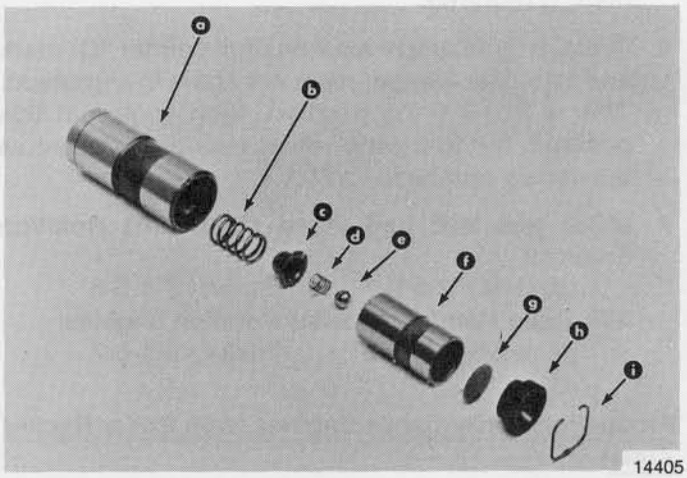


04982

IMPORTANT: This 1-turn preload adjustment must be done slowly to allow lifter to adjust itself, thus preventing possibility of interference between inlet valve head and top of piston which might result in internal damage and/or bent push rods.

5. Repeat Steps 2-3-4 to adjust other valves.
6. Remove rocker stoppers after all valves are adjusted.
7. After valves have been adjusted, complete the following:
   a. Install new gaskest (or RTV), and install covers. Torque to specifications.
   b. Adjust carburetor idle speed and mixture.
   c. Start engine and check for leaks.

Hydraulic Valve Lifters



14405

a - Lifter Body
b - Plunger Spring
c - Check Ball Retainer
d - Check Ball Spring
e - Check Ball
f - Plunger
g - Metering Valve
h - Push Rod Seat
i - Push Rod Seat Retainer

Hydraulic Valve Lifter Assembly

Hydraulic valve lifters require little attention. Lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

Locating Noisy Lifters

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft. (1.2m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

1. Hard rapping noise -- Usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or "pick-up" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise -- Probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train -- This will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking -- Probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out-of-round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc, is shown to exist in one unit, it more likely exists in all the units, thus it would only be a matter of time before all lifters caused trouble.

Removal

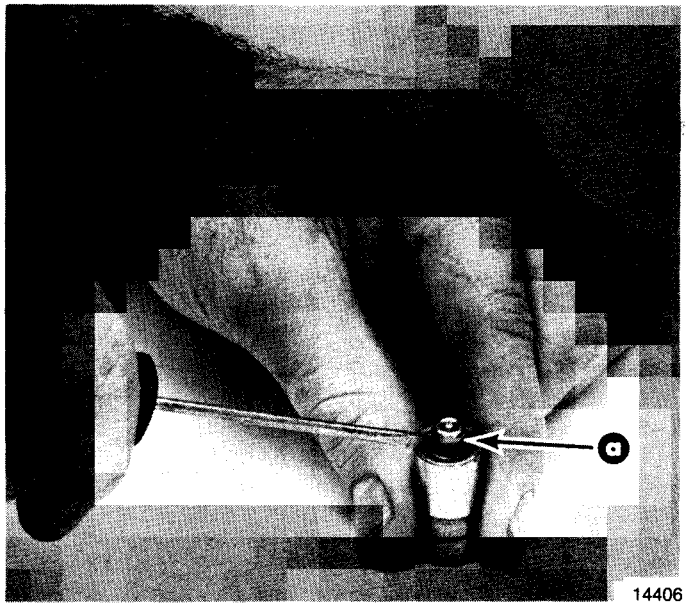
1. Remove intake manifold.
2. Remove valve mechanism.
3. Remove valve lifters.

IMPORTANT: Keep push rod and hydraulic valve lifter from each valve together as a matched set and mark them so they can be reinstalled in the same location later.

Disassembly

IMPORTANT: The internal parts of each hydraulic lifter assembly are matched sets. Do not intermix the parts.

1. Hold plunger down with a push rod and remove push rod seat retainer with the blade of a small screwdriver.
2. Remove push rod seat and metering valve.
3. Remove the plunger, ball check valve assembly and the plunger spring.
4. Remove the ball check valve and spring by prying the ball retainer loose from the plunger with the blade of a small screwdriver.



a - Check Ball Retainer

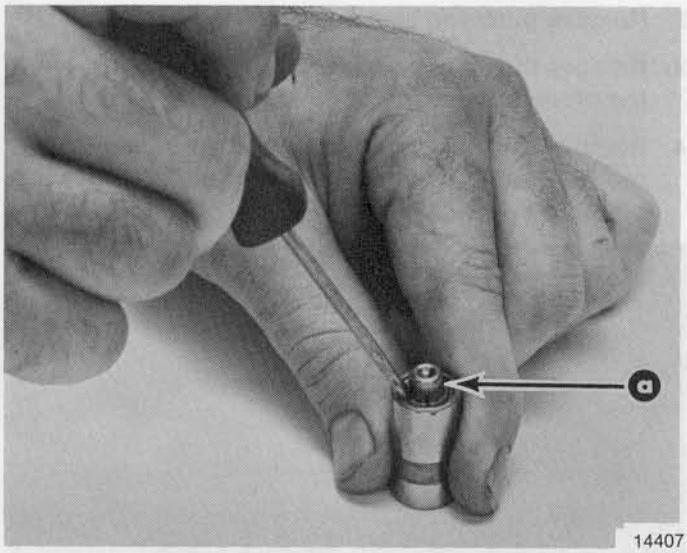
Removing Ball Check Valve

Cleaning and Inspection

Thoroughly clean all parts in cleaning solvent and inspect them carefully. If any parts are damaged or worn, entire lifter assembly should be replaced. If outer lifter body wall is scuffed or worn, inspect cylinder block lifter bore. If bottom of lifter is scuffed or worn, inspect camshaft lobe. If push rod seat is scuffed or worn, inspect push rod.

Reassembly

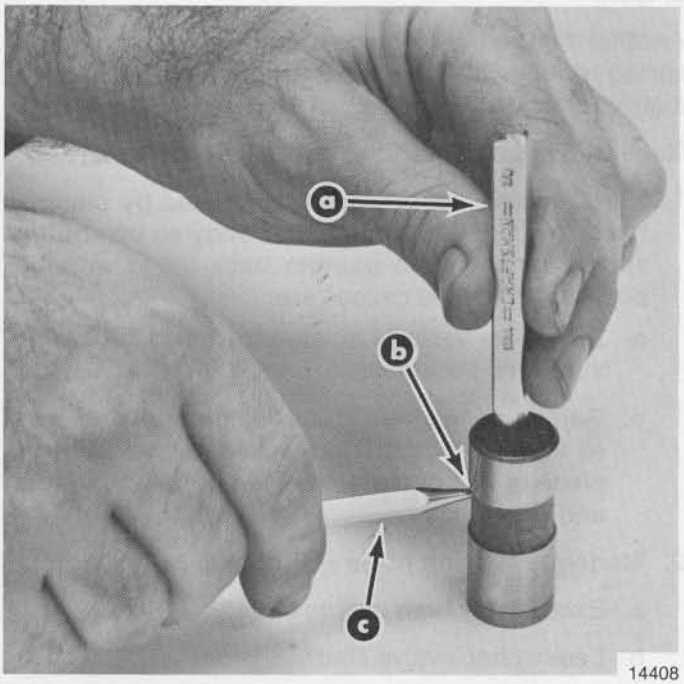
1. Place the check ball in small hole in bottom of the plunger.
2. Insert check ball spring on seat in ball retainer and place retainer over ball so that spring rests on the ball. Carefully press the retainer into position in plunger with the blade of a small screwdriver.



a - Check Ball Retainer

Installing Check Ball Valve

3. Place the plunger spring over the ball retainer and slide the lifter body over the spring and plunger, being careful to line up the oil feed hole in the lifter body and plunger.
4. Fill the assembly with oil, then insert the end of a 1/8" drift pin into the plunger and press down on check ball until hole in lifter body aligns with hole in plunger.
5. Insert a 1/16" drift pin through both oil holes to hold the plunger down against the lifter spring tension.



a - 1/8" Drift Pin
b - Oil Feed Hole
c - 1/16" Drift Pin

Oil Feed Holes Aligned and Drift Pin Installed

IMPORTANT: Do not attempt to force or pump the plunger.

6. Remove the 1/8" drift pin and refill assembly with oil.
7. Install the metering valve, push rod seat and push rod seat retainer.
8. Press down on the push rod seat with a push rod and remove 1/16" drift pin from lifter. The lifter is now completely assembled, filled with oil and ready for installation.

Installation

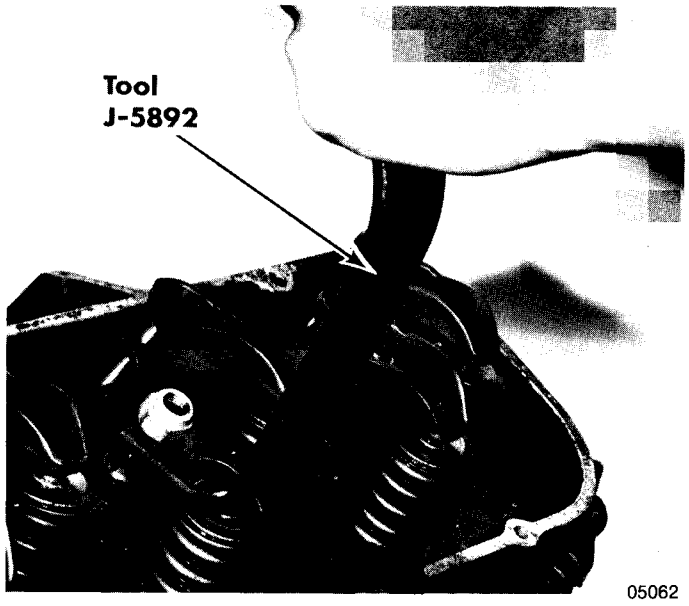
IMPORTANT: Before installing lifters, coat the bottom of the lifter with engine oil. If new lifters or a new camshaft has been installed, an additive containing EP lube (such as Quicksilver 4-Cycle Super Engine Oil Supplement) should be poured over camshaft lobes before installing lifters.

1. Install hydraulic valve lifters.
2. Install intake manifold.
3. Install and adjust valve mechanism as outlined.
4. Install rocker arm cover.
5. Start engine and check for leaks.

Valve Stem Oil Seal/Valve Spring

Removal

1. Remove rocker arm cover.
2. Remove spark plug, rocker arm and push rod on cylinder(s) to be serviced.
3. Position piston (in cylinder to be serviced) at TDC, to prevent valve from dropping out of valve guide.
4. Compress valve spring with J-5892 Tool. Remove valve locks and all other components.



05062

a - J-5892 Tool
b - Rocker Arm Nut

Compressing Valve Spring

5. Remove valve stem oil seal(s) from valve (except later style production-performance engines).

NOTE: On later style production-performance engines, valve stem oil seal is part of valve cap. If oil seal requires replacement, entire valve cap and seal assembly must be replaced.

Standard and Earlier Style Production-Performance

1. Install valve rotator or shim in position on valve spring seat. (Rotator is used on exhaust valve; shim is used on intake valve.)
2. Coat valve stem oil seal with engine oil and install over valve stem.

IMPORTANT: If new pressed-on type intake valve stem oil seals are to be used, install seals in accordance with instuctions which accompany them.

3. If removed, install damper in valve spring.
4. Set valve spring and damper assembly and valve spring cap in position over valve stem.
5. Compress spring with J-5892 tool and install valve locks. Then release compressor tool, making sure that locks seat properly in groove of valve stem.

NOTE: Grease may be used to hold locks in place while releasing compressor tool.

IMPORTANT: Compress valve spring only enough to install valve locks in next step. Excess compression could cause valve spring cap to damage seal.

454 CID Engines - Later Style Production-Performance

1. Make sure that shim is in position on valve spring seat.
2. Set valve springs and damper assembly and valve spring cap and oil seal assembly in position over valve stem.
3. Compress spring with J-5892 tool and install valve locks. Then release compressor tool, making sure that locks seat properly in groove of valve stem.

NOTE: Grease may be used to hold locks in place while releasing compressor tool.

Cylinder Head

Removal

1. Drain engine cooling system.
2. Remove exhaust manifolds.
3. Remove intake manifold.
4. Remove valve mechanism.

NOTE: Remove any component attached to front or aft end of cylinder head to be removed.

5. Remove spark plugs.
6. Remove spark plug wire retainers from cylinder head.
7. Remove cylinder head bolts, cylinder head and gasket.
8. Place cylinder head on 2 blocks of wood to prevent damage.

Cleaning and Inspection

For cleaning and inspection, refer to "Cylinder Head and Valve Conditioning".

Installation

⚠CAUTION

Gasket surfaces on both head and block must be clean of any foreign matter and free of nicks or deep scratches. Cylinder bolt threads in block and threads on cylinder head bolts must be clean. (Dirt will affect bolt torque.)

1. On engines using a stainless steal gasket, coat both sides of new gasket with Perfect Seal. Spread sealer thin and even. Too much sealer may hold gasket away from head or block.

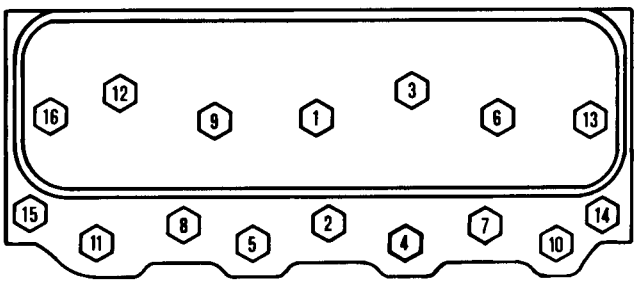
⚠CAUTION

Use no sealer on engines which have a composition steel asbestos gasket.

2. Place gasket in position over dowel pins.
3. Carefully guide cylinder head into place over dowel pins and gasket.
4. Coat threads of cylinder head bolts with Perfect Seal and install bolts finger-tight.
5. Tighten each cylinder head bolt in a little at a time in sequence shown in torque sequence chart until specified torque is reached.
6. Install exhaust manifolds as outlined.
7. Install intake manifold as described.
8. Install and adjust valve mechanism as outlined.
9. Install valve covers.
10. Install spark plugs. Torque spark plugs to specifications.
11. Install spark plug wire retainers.

NOTE: Install any component that was removed from the front or aft end of cylinder head.

12. Run engine, adjust timing and check for leaks.

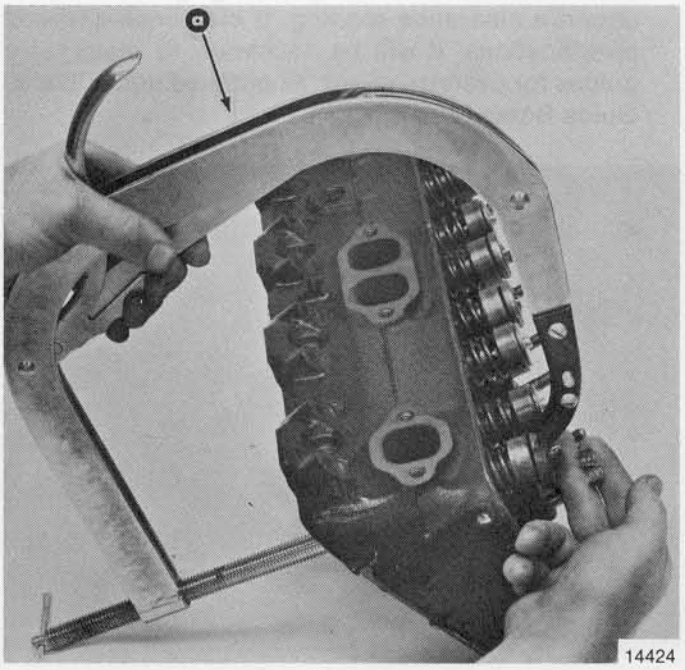


Cylinder Head Torque Sequence

Cylinder Head and Valve Conditioning

Disassembly

1. With cylinder head removed, remove rocker arms and components (if not previously done).
2. Compress valve springs with J-8062 tool and remove valve retainers. Release compressor tool and remove all valve components.
3. Remove valves from cylinder head and place valves in a rack in their proper sequence for reassembly in their original positions.

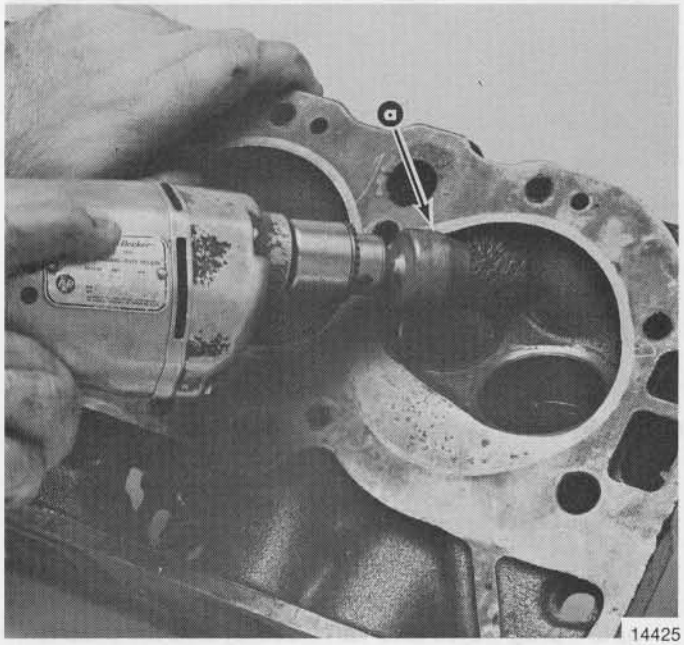


a - J-8062 Tool

Compressing Valve Spring

Cleaning

1. Clean all carbon from combustion chambers and vale ports with J-8089 tool.

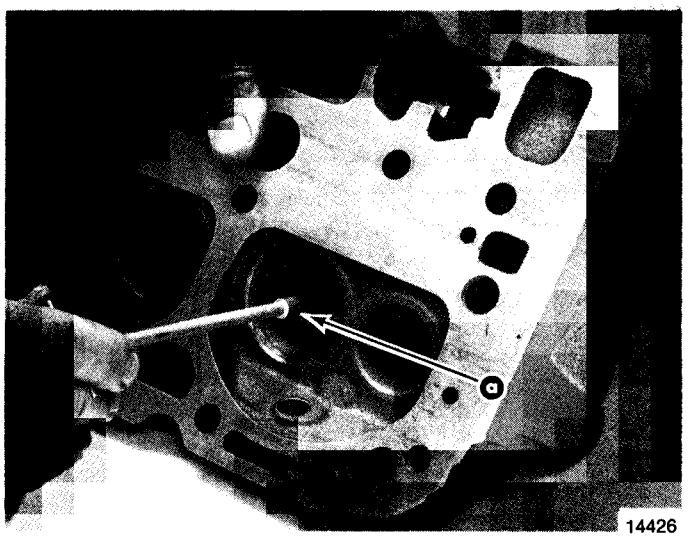


a - J-8089 Tool

Cleaning Combustion Chambers

2. Thoroughly clean valve guides with J-8101 tool.
3. Clean all push rods, rocker arms and push rod guides.
4. Clean carbon from valves on a buffing wheel.
5. Clean carbon deposits and gasket material from cylinder head mating surfaces.

Checking Valve Spring Tension

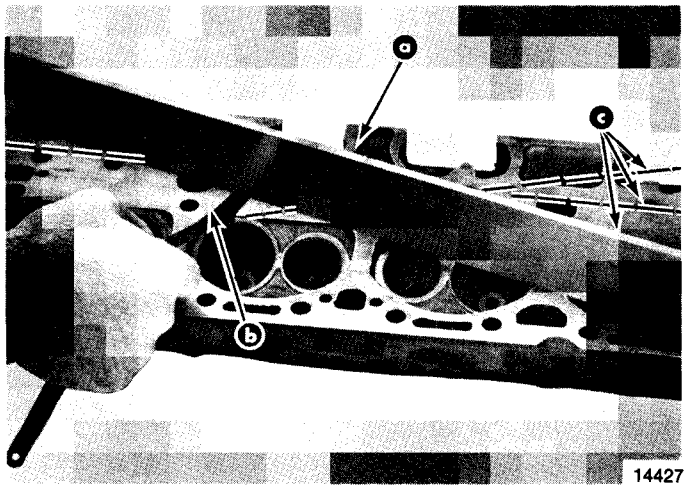


Cleaning Valve Guides

Inspection

1. Inspect cylinder head for cracks in the exhaust ports, combustion chambers (especially around spark plug holes and valve seats) and for cracks in external surface of water jacket. Replace head if cracked.
2. Inspect cylinder head gasket surface for burrs, nicks, erosion or other damage. Also, check flatness of cylinder head gasket surface, using a machinists straight edge and feeler gauges as shown. Refer to "Specifications".

IMPORTANT: Cylinder head to block gasket surface should be resurfaced if out-of-flat more than specified. When resurfacing gasket surface, cylinder head to intake manifold gasket surface also must be milled to provide proper alignment between manifold and head.



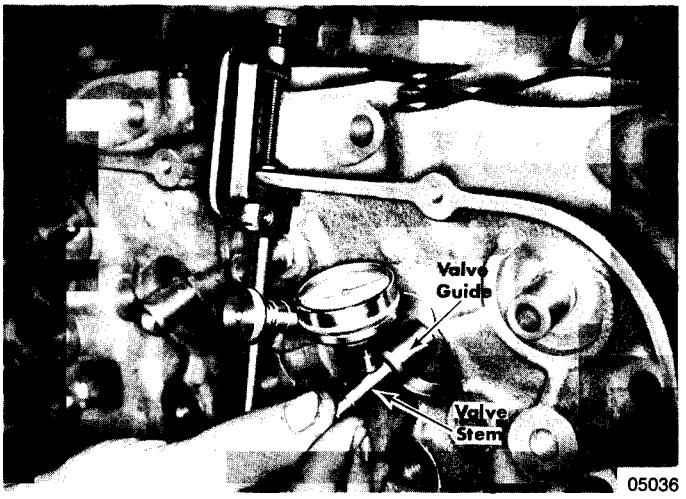
a - Straight Edge
b - Feeler Gauge
c - Take Measurements Diagonally Across Head (Both Ways) and Straight Down Center Head

Checking Gasket Surface of Cylinder Head for Flatness

3. Inspect valves for burned heads, cracked faces or damaged stems.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky functioning of valve and disturb engine smoothness.

4. Measure valve stem clearance as follows: Clamp a dial indicator on one side of cylinder head rocker arm cover gasket rail, locating indicator so that movement of valve stem from side-to-side (crosswise to the head) will cause a direct movement of indicator stem. Indicator stem must contact side of valve stem just above valve guide. With valve head dropped about 1/16" (2mm) off valve seat, move valve stem from side-to-side, using light pressure to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves, as outlined under "Valve Guide Bores Repair".



Measuring Valve Stem Clearance

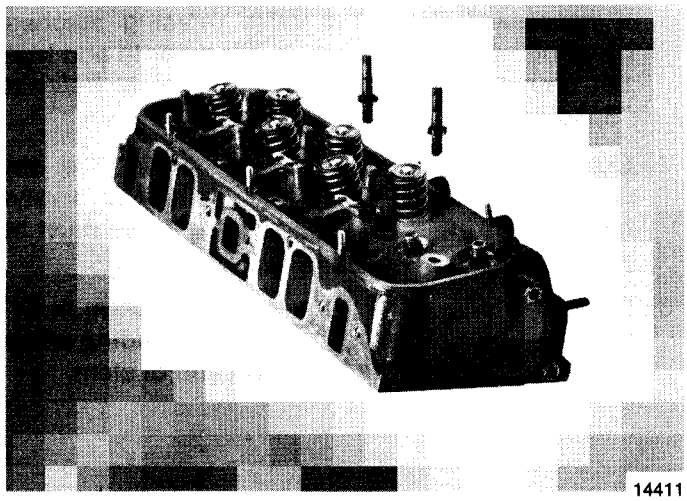
5. Check valve spring tension with J-8056 spring tester.

IMPORTANT: Springs should be compressed to specified height and checked against specification. Springs should be replaced if not within 10 lbs. ft. (13.5 N.m) of specified load.

6. Inspect rocker arm studs for wear or damage. Inspect push rod guides for wear or damage.

IMPORTANT: Rocker arm studs are threaded into the cylinder head. Coat threads on cylinder head end of rocker arm studs with sealer before assembling to cylinder head.

Push rod guides are attached to cylinder head by rocker arm studs. Replace if worn and torque rocker arm studs to specifications.



454 Cylinder Head

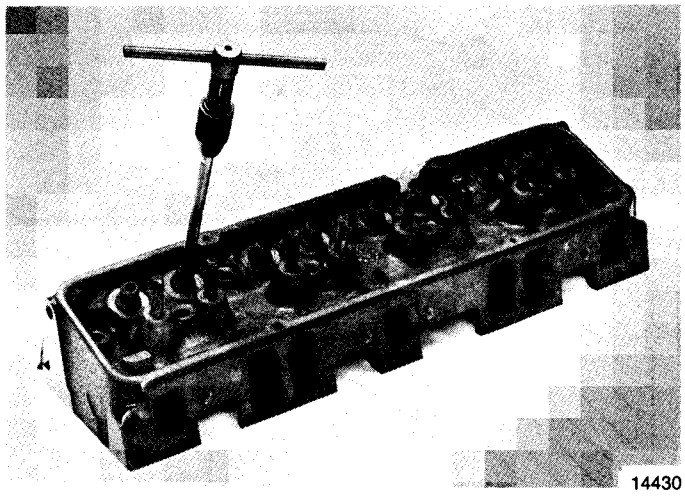
Valve Guide Bore Repair

If .015" oversize valves are required ream valve guide bores for oversize valves, as follows:

1. Measure valve stem diameter of old valve being replaced and select proper size Valve Guide Reamer from chart below.

Standard Valve Stem Diameter	Reamer Required for Oversize Valve
.372	J-7049-5

2. Ream valve guide bores, as shown.
3. Remove the sharp corner created by reamer at top of valve guide.



Reaming Valve Guides

Valve Seat Repair

Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

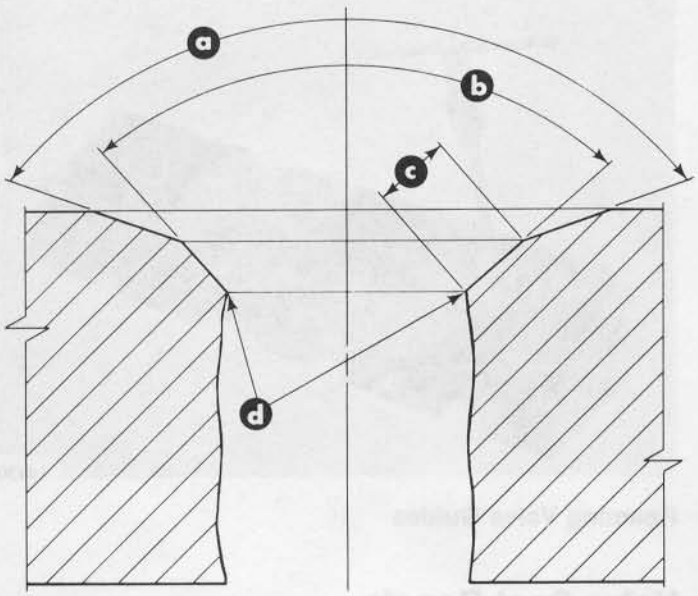
Another important factor is valve head cooling. Good contact between each valve and its seat in head is important to insure that heat in valve head will be properly dispersed.

Several different types of equipment are available for reseating valve seats. Equipment manufacturer's recommendations should be followed carefully to attain proper results.

Regardless of type of equipment, however, it is essential that valve guide bores be free from carbon or dirt to insure proper centering of pilot in valve guide.

1. Install expanding pilot in valve guide bore and expand pilot.
2. Place roughing stone or forming stone over pilot and clean up valve seat only. Use a stone that is cut to specifications.
3. Remove roughing stone or forming stone from pilot, place finishing stone (cut to specifications) over pilot and cut just enough metal from seat to provide a smooth finish. Refer to "Specifications".

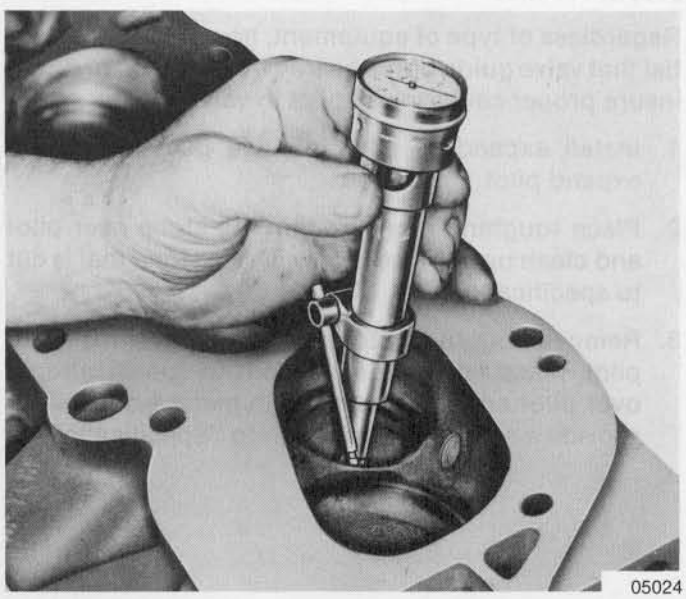
4. Narrow down valve seats to specified width by grinding with a 30° stone to lower seat and a 60° stone to raise seat.



a - Top Edge "Approach Angle" (30°)
b - Seat Angle
c - Seat Width
d - Bottom Edge (60°)

Valve Seat in Cylinder Head

5. Remove expanding pilot and clean cylinder head carefully to remove all chips and grindings from above operations.
6. Measure valve seat width. See "Specifications".
7. Measure valve seat "out-of-round". See "Specifications".



Measuring Valve Seat Concentricity

Valve Repair

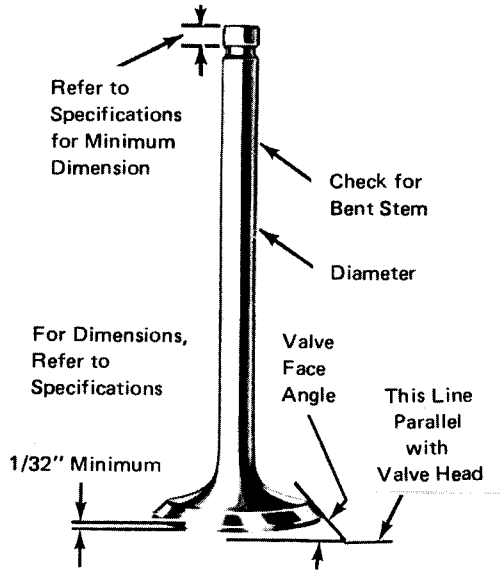
Pitted valves can be refaced to proper angle on a valve grinder, thus insuring correct relation between cylinder head seat and valve mating surface. Replace valves with excessive wear on stems or valves which are warped excessively. When an excessively-warped valve head is refaced, a knife edge will be ground on part or all of the valve head, due to amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or pre-ignition caused by heat localizing in this knife edge. If edge of valve head is less than 1/32" (.8mm) thick after grinding, replace the valve.

Various equipment is available for refacing valves. Manufacturer's recommendations should be carefully followed to attain proper results.

1. If necessary, dress the valve refacing machine grinding wheel to make sure it is smooth and true. Set chuck at angle specified for valve. Refer to "Specifications".
2. Continue grinding until valve face is true and smooth all around the valve. If this makes valve head thin [1/32" (.8mm) minimum], valve must be replaced, or valve will overheat and burn.
3. Remove valve from chuck and place stem in "V" block. Feed valve squarely against grinding wheel to grind any pit from rocker arm end of stem.

IMPORTANT: Only extreme end of valve stem is hardened to resist wear. Do not grind end of stem excessively.

4. After cleaning valve face and cylinder head valve seat of grinding particles, make pencil marks about 1/4" (6mm) across the valve face, place valve in cylinder head and give valve 1/2-turn in each direction while exerting firm pressure on head of valve.
5. Remove valve and check face carefully. If all pencil marks have not been removed at point of contact with valve seat, repeat refacing operation and again recheck for proper seating.



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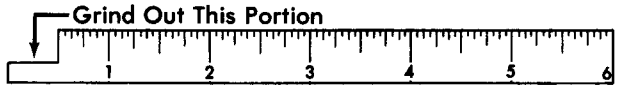
Critical Valve Dimensions

Reassembly

- Lubricate valve guides and valve stems with engine oil.
- Install each valve in the port from which it was removed or to which it was fitted.
- Install valve stem oil seal, valve spring(s) and related parts on each valve as explained under "Valve Stem Oil Seal and/or Valve Spring".
- Compress valve spring with Tool J-8062.
- Check installed height of the valve springs with a narrow, thin scale. A cutaway scale will help. Measure from top of spacer (spring seat) to top of valve spring. If this exceeds specified height, install a valve spring seat shim approximately 1/16" (1.6mm) thick. At no time should spring be shimmed to give an installed height under minimum specified.



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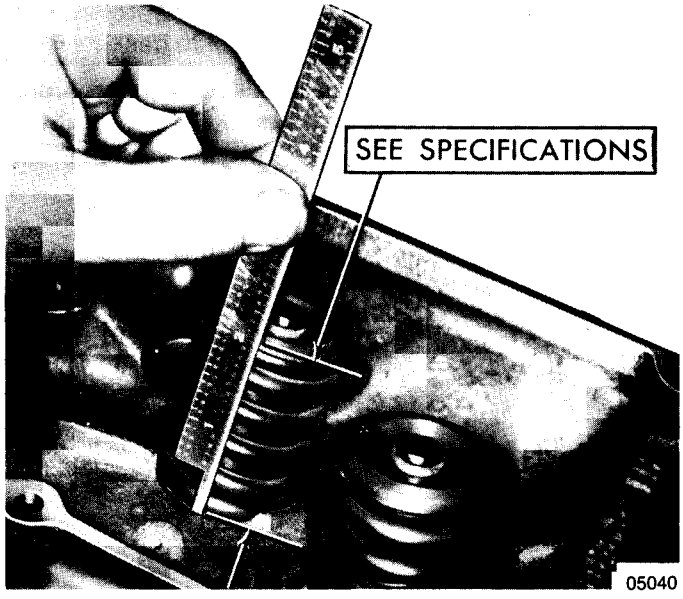
Cutaway Scale



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Measuring Valve Spring Installed Height

Oil Pan

Removal

1. Drain coolant.
2. Drain crankcase oil.
3. Remove oil dipstick and tube, if required.
4. Remove oil pan and discard gaskets.

IMPORTANT: Determine which side of engine oil dipstick tube mounting hole is on and use appropriate oil pan, gasket, baffle, (if used) dipstick tube and dipstick. Refer to Parts Manual.

Installation

1. Thoroughly clean gasket and seal surfaces on oil pan, cylinder block, rear main bearing cap and crankcase front cover.

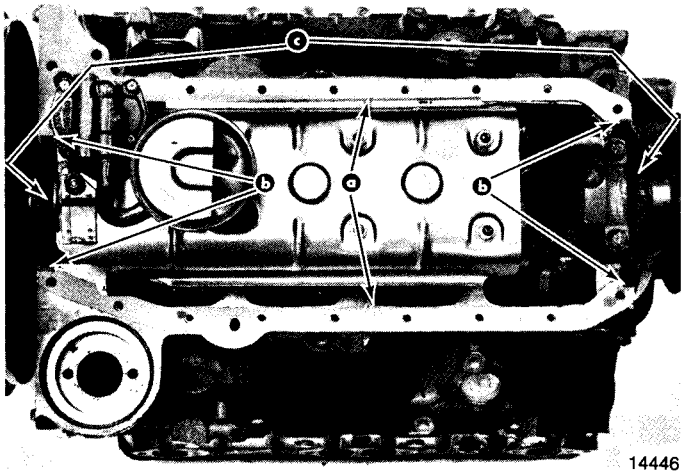
IMPORTANT: 454 CID MIE and some MCM engines use a rubber plug to block off threaded holes into the cylinder block (located on each side of the rear main bearing cap). If oil pan does not have thru hole for attaching screw, install rubber plug to prevent oil leak.

2. Coat both sides of oil pan side gaskets with Perfect Seal and place gaskets in position on each side of cylinder block.

3. Apply a 1/8" (3mm) bead of RTV Sealer to front and rear seal mating surfaces on cylinder block rear main bearing cap, front cover and gaskets.

IMPORTANT: RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

4. Install new front and rear seals, being sure ends of seals are butted properly against side gaskets.
5. Apply a 1/8" (3mm) bead of RTV Sealer to outer surface of seals. This is extremely important on inboard and V-drive engines which have aluminum oil pans.

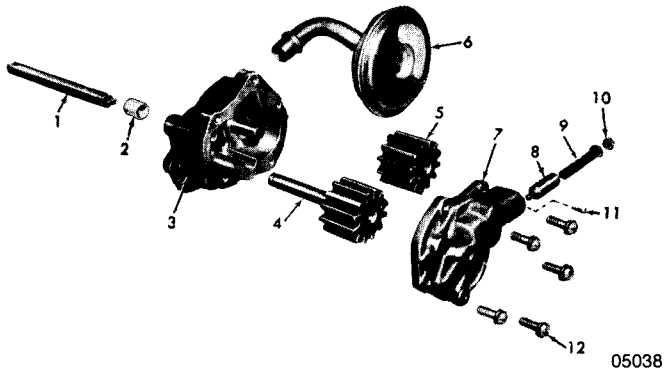


a - Coat Both Sides with Perfect Seal
b - Apply RTV to Mating Surfaces
c - Apply RTV to Outer Surface of Seals

Typical Oil Pan Gasket and Seal Locations

6. Carefully position oil pan against the block, being careful not to disturb gaskets and seals. Install oil pan attaching screws and washers. Torque screws to specifications, starting from center and working outward in each direction.
7. Install oil dipstick tube and dipstick.
8. Install engine in boat. Fill engine with oil, start engine and check for leaks.

Oil Pump



1 - Shaft Extension
2 - Shaft Coupling
3 - Pump Body
4 - Drive Gear and Shaft
5 - Idler Gear
6 - Pickup Screen and Pipe
7 - Pump Cover
8 - Pressure Regulator Valve
9 - Pressure Regulator Spring
10 - Washer
11 - Retaining Pin
12 - Screws

Oil Pump Assembly

The oil pump consists of 2 gears and a pressure regulator valve enclosed in a 2-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft.

A baffle is incorporated on pick up screen to eliminate pressure loss and engine oil pump tubes are bent at special angles.

Removal

1. Remove oil pan.
2. Remove pump to rear main bearing cap bolt and remove pump and extension shaft.

Disassembly

1. Remove pump cover attaching screws and pump cover.

IMPORTANT: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear, drive gear and shaft from pump body.
3. Remove retaining pin, pressure regulator valve and related parts.

IMPORTANT: 454 CID Engines: Pickup screen and pipe assembly cannot be removed from pump.

IMPORTANT: DO NOT disturb pickup screen on pipe. This is serviced as an assembly.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage or excessive wear.
4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen or pipe.
7. Check pressure regulator valve for fit.

IMPORTANT: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.

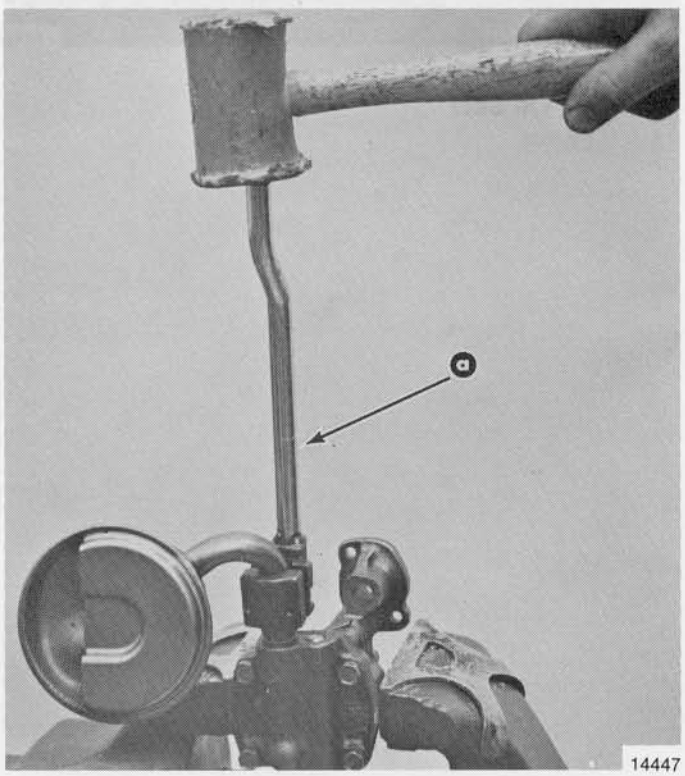
Reassembly

⚠CAUTION

Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to oil pan rails when oil pump is installed.

IMPORTANT: Oil internal parts liberally before installation.

1. Install pressure regulator valve and related parts.
2. Install drive gear and shaft in pump body.



a - J-8369 Tool

Installing New Pickup Screen and Pipe Assembly

3. Install idler gear in pump body with smooth side of gear toward pump cover opening. Align marks made in disassembly.
4. Install pump cover and torque attaching screws to specifications.
5. Turn drive shaft by hand to check for smooth operation.

Installation

1. Assemble pump and extension shaft to rear main bearing cap, aligning slot on top end of extension shaft with drive tang on lower end of distributor drive shaft.
2. Install pump to rear main bearing cap and torque to specifications.

IMPORTANT: Oil pump screen is installed with bottom edge parallel to oil pan rails.

3. Install oil pan as outlined.

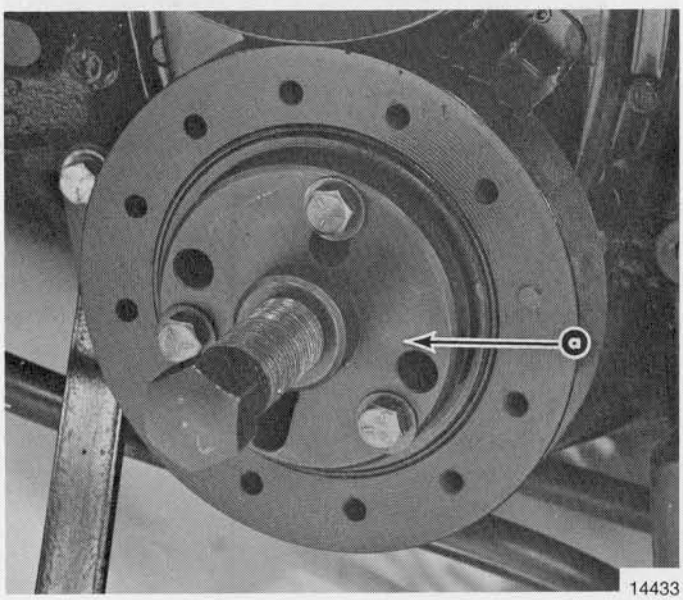
Torsional Damper

Removal

1. Remove drive belts.
2. Remove drive pulley, then remove damper retaining bolt.

IMPORTANT: Do not use a universal claw type puller to remove torsional damper (in next step) as outside ring of damper is bonded in rubber to the hub and use of claw type puller may break the bond.

3. Remove damper with Tool J-23523-03.



a - J-23523-03 Tool

Removing Torsional Damper

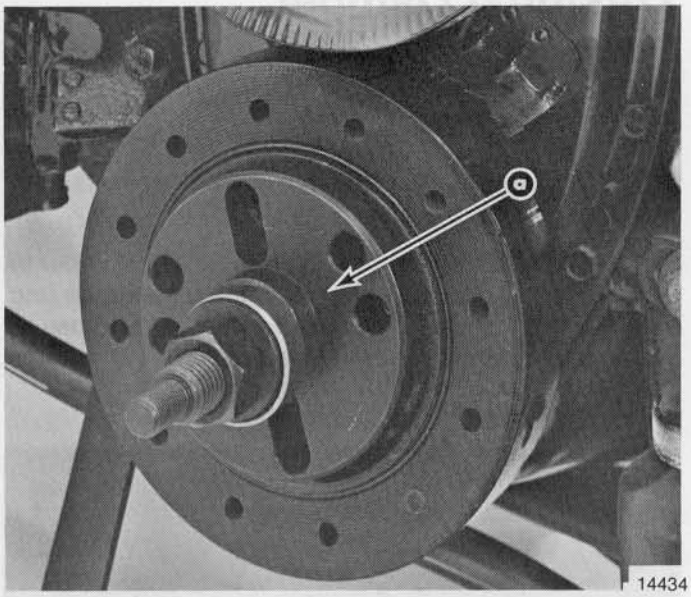
Installation

IMPORTANT: The inertia weight section of torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Coat front cover seal contact area (on damper) with engine oil.
2. Pull damper onto crankshaft, using Tool J-23523-03, as follows:
   a. Install appropriate end of threaded rod into crankshaft.

IMPORTANT: Be sure to install threaded rod in crankshaft so that at least 1/2" (13mm) of thread engagement is obtained to prevent damage to threads.

   b. Install plate, thrust bearing, washer and nut on rod.
   c. Pull damper onto crankshaft (by turning nut) until it bottoms-out.



a - J-23523-03 Tool

Installing Torsional Damper

   d. Remove tool from crankshaft, then, install damper retaining bolt and torque to specifications.
3. Install drive pulleys.
4. Install drive belts.

Crankcase Front Cover/Oil Seal

Oil Seal Replacement (Without Removing Front Cover)

1. Remove torsional damper.
2. Pry seal out of cover from the front with a large screwdriver, being careful not to distort front cover or damage crankshaft seal surface.
3. Install new seal with open end of seal inward, using Tool J-22102. Drive seal in until it just bottoms out. Do not use excessive force.
4. Reinstall torsional damper.

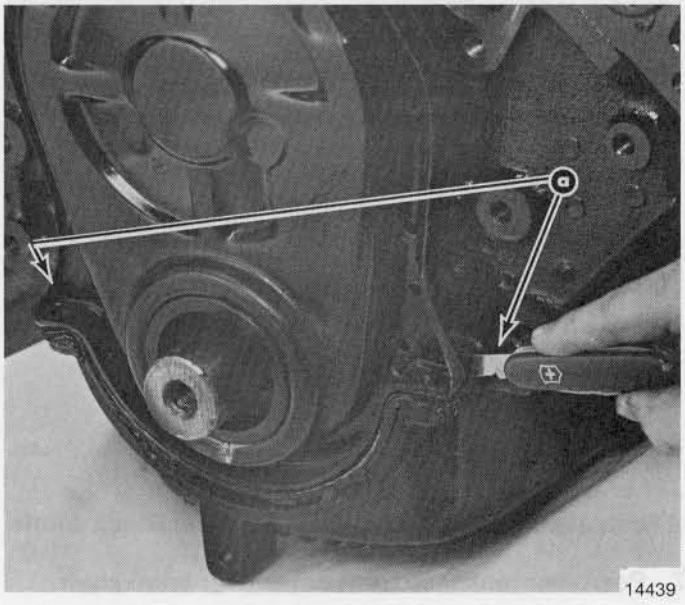
a - J-22102 Tool

Installing Oil Seal

Removal

NOTE: The following instructions outline removal of front cover without removing oil pan. If oil pan must be removed for other engine service, remove oil pan and disregard Step 3, 4 and 5, following.

1. Remove torsional damper.
2. Remove water circulating pump.
3. Remove 2 oil pan to front cover attaching screws.
4. Remove crankcase front cover attaching screws and timing pointer, then pull cover slightly forward (only enough to permit cutting of oil pan front seal).
5. Using a sharp knife, cut oil pan front cover seal flush with cylinder block on both sides of cover.



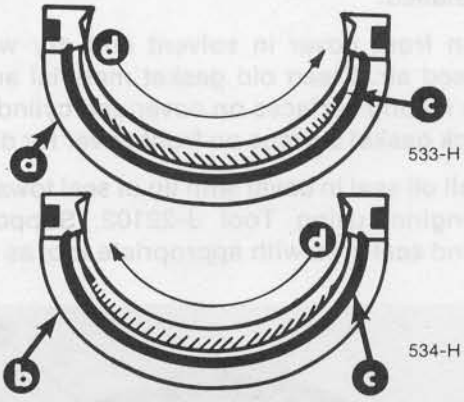
a - Cut Off Seal on Both Sides

Cutting Oil Pan Front Seal

6. Remove front cover and attached portion of oil pan front seal. Remove and discard oil pan front seal and front cover gasket.
7. If damaged, drive oil seal out of front cover (from the rear) with a punch.

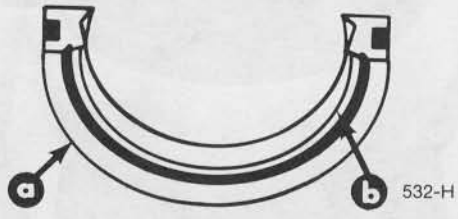
Installation

IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



a - MCM and MIE (L.H.) Rotation Engines
b - MIE (R.H.) Rotation Engines
c - Seal Lip Toward Inside of Engine
d - Rotation of Crankshaft as Viewed From Flywheel End Looking Forward

Front Seals WITH Helical Grooves

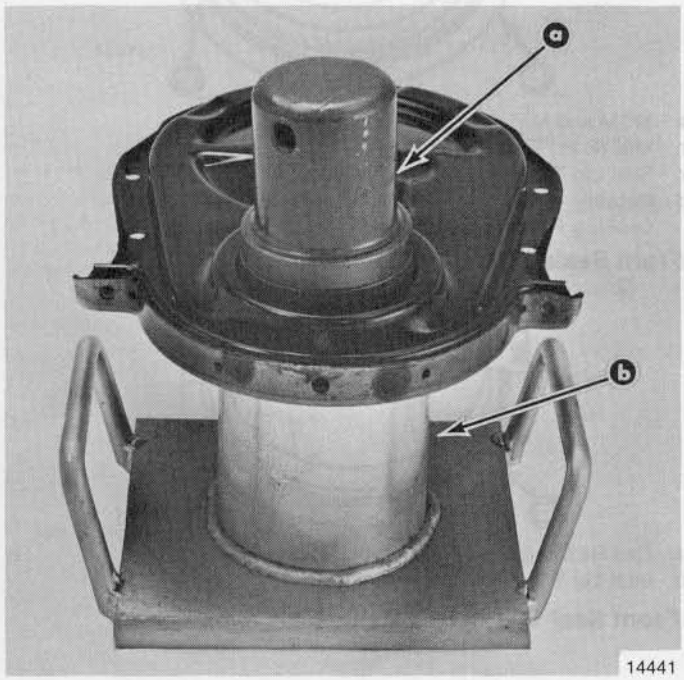


a - Can Be Used On Any Rotation Engine
b - Seal Lip Toward Inside of Engine

Front Seal WITHOUT Helical Grooves

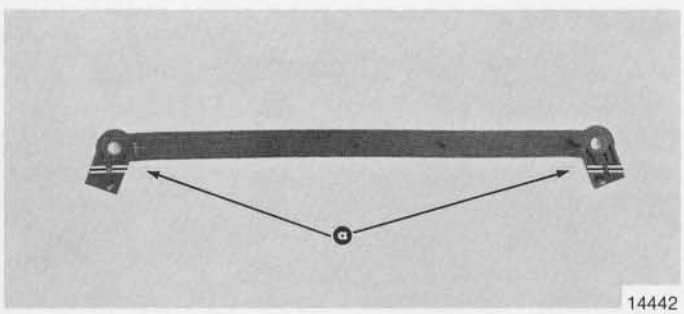
NOTE: The following instructions outline installation of front cover without oil pan removed. If oil pan has been removed for other engine service, disregard Step 3, 4, 6, 8 and 10 and install oil pan after front cover has been installed.

1. Clean front cover in solvent and dry with compressed air. Clean old gasket material and sealer from mating surfaces on cover and cylinder block. Check gasket surface on front cover for distortion.
2. Install oil seal in cover with lip of seal toward inside of engine, using Tool J-22102. Support cover around seal area with appropriate tool as shown.



a - J-22102 Tool
b - Support (To Prevent Distorting Cover)

3. Coat both sides of front cover gasket with Perfect Seal and place in position on engine. Be sure to position gasket over dowel pins.
4. Cut tabs from the new oil pan front seal.



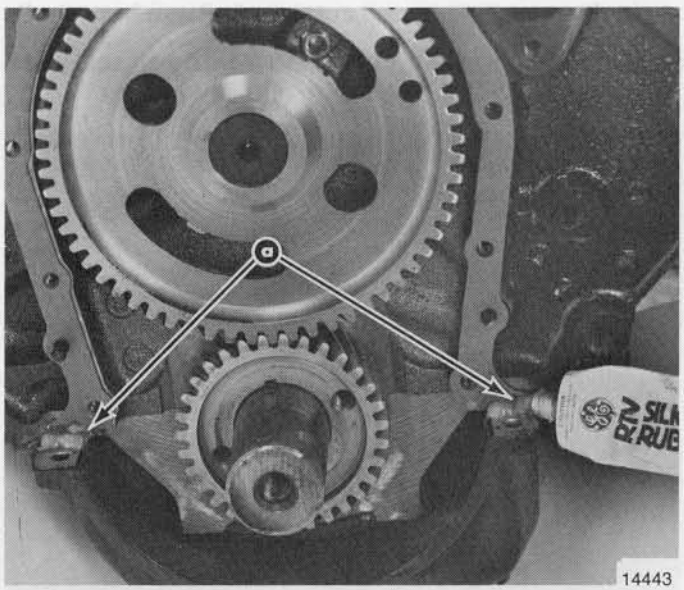
a - Cut This Portion From New Seal

Oil Pan Front Seal Modification (Without Oil Pan Removed Only)

5. Apply a 1/8" (3mm) wide bead of RTV Sealer across entire length of seal surface on front cover. Install seal to front cover, pressing tips into holes provided in cover. After seal is installed, place a 1/8" wide bead of RTV Sealer across entire length of outer seal surface.

IMPORTANT: Use of RTV Sealer on outer surface of seal is essential on inboard and V-drive engines which have aluminum oil pans.

6. Apply a 1/8" (3mm) bead of RTV Sealer to the joints formed where oil pan mates against cylinder block.



a - 1/8" (3mm) Wide Bead of RTV Sealer

RTV Sealer Applied to Oil Pan to Cylinder Block Joints

7. Position crankcase front cover over crankshaft.
8. Press front cover downward against oil pan until holes in cover align with dowel pins on block and push cover over pins. Install and partially tighten the 2 oil pans to front cover attaching screws to retain cover.
9. Install front cover attaching screws and timing pointer (if removable). Torque screws to specifications.
10. Torque 2 oil pans to front cover attaching screws (installed in Step 8) to specifications.
11. Install torsional damper.
12. Install water circulating pump.
13. Start engine and check for water and oil leaks.

Flywheel

Removal

1. Remove engine from boat.
2. Remove transmission, if so equipped.
3. Remove flywheel housing and related parts, if applicable.
4. **On I-Drive Engines:** Remove flywheel and coupler attaching nuts and washers and remove coupler and flywheel.
5. **On Engines with Borg-Warner Transmission:** Remove drive plate attaching screws and washers and remove drive plate, then remove flywheel attaching screws and washers and remove flywheel.

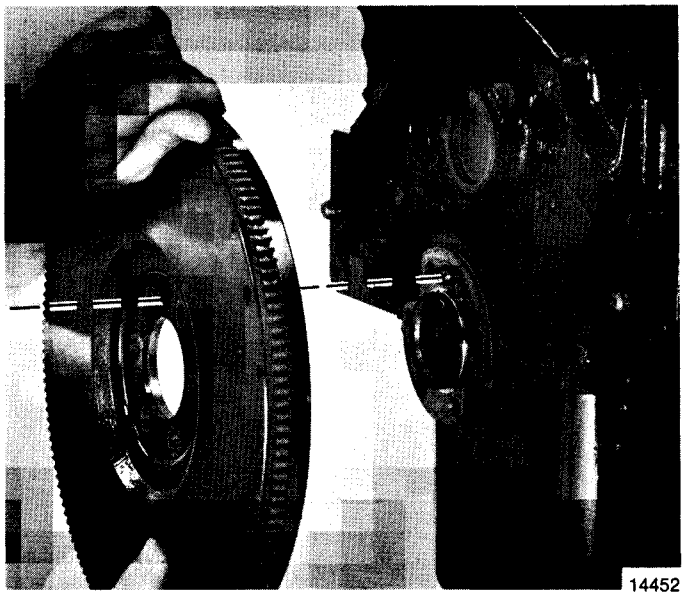
IMPORTANT: If crankshaft is to be replaced, but old pilot bushing is to be reused, bushing can be removed without damage by filling pilot bushing cavity with grease, then, inserting an old transmission input shaft in bore of bushing and hitting it with a hammer. This will create hydraulic pressure in pilot bushing cavity which should force bushing out.

Inspection

1. Inspect drive plate for wear, on engines so equipped.
2. Check flywheel ring gear for worn or missing teeth.
3. Inspect engine coupler, on engines so equipped.

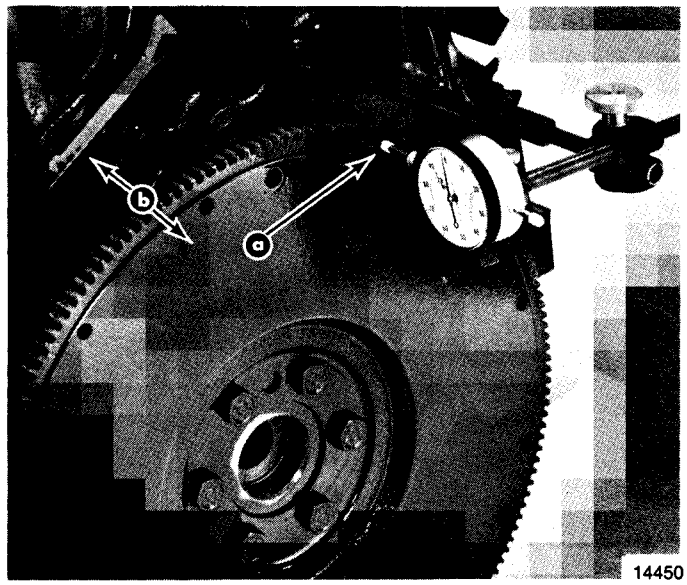
Installation

1. Clean mating surfaces of flywheel and crankshaft.



Flywheel Installation

2. **On I-Drive Engines:**
   a. If removed, apply Loctite 35 to threads of studs and install in crankshaft.
   b. Align dowel hole in flywheel with dowel hole or dowel in crankshaft flange and place flywheel in position on flange.
   c. Install coupler and secure it and flywheel with washers and elastic stop nuts. Torque nuts to specifications.
3. **On Engines with Borg-Warner or Mercury Marine Transmission:**
   a. Align dowel hole in flywheel with dowel or dowel hole in crankshaft flange and place flywheel in position on flange.
   b. Secure flywheel with screws and lockwashers. Torque screws to specifications.
   c. Install drive plate and torque to specifications.
4. Check flywheel runout by mounting dial indicator on machined surface of flywheel.
5. Runout should not exceed .008" (.203mm). If excessive, remove flywheel and check for burrs or replace flywheel.
6. Install flywheel housing and related parts, if so equipped. Torque flywheel housing screws to specifications.
7. Torque flywheel housing cover screws to specifications.
8. Install transmission, if so equipped.
9. Install engine in boat.



a - .008" (.203mm) Max. Runout
b - Hold Flywheel and Crankshaft Forward or Rearward As Far As It Will Go When Taking Reading

Checking Flywheel Runout

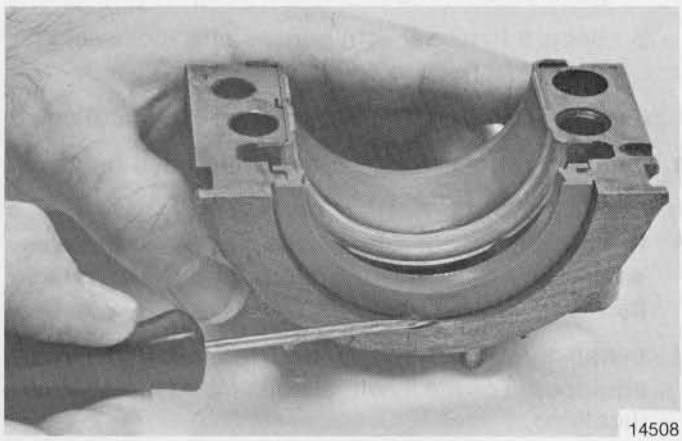
Oil Seal (Rear Main)

Replacement

Rear main bearing oil seal can be replaced (both halves) without removing crankshaft.

IMPORTANT: Always replace upper and lower seal as a unit. Install with lip facing toward inside of engine.

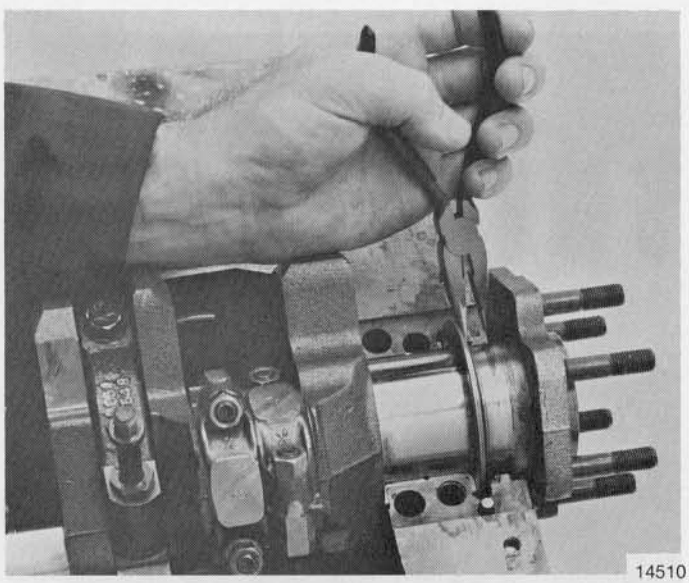
1. Remove oil pan and oil pump.
2. Remove rear main bearing cap.
3. Remove lower half of oil seal from the bearing cap by prying from the bottom with a small screwdriver. Be careful not to damage seal seating surface.



14508

Removing Lower Half of Oil Seal

4. Using a hammer and a soft metal pin punch, tap upper half of oil seal on one end until it protrudes far enough on the other end to remove it with a pliers.



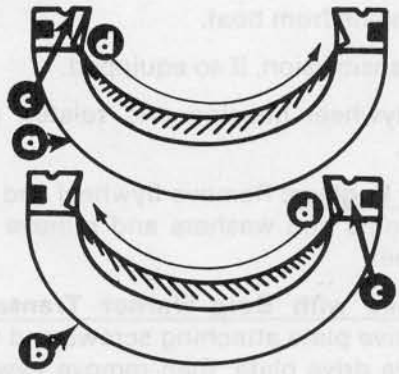
14510

Removing Upper Half of Oil Seal

5. Clean, rear main bearing cap, cylinder block and crankshaft with solvent and blow dry with compressed air. Be sure all of the old sealer is removed from bearing cap and cylinder block mating surfaces.

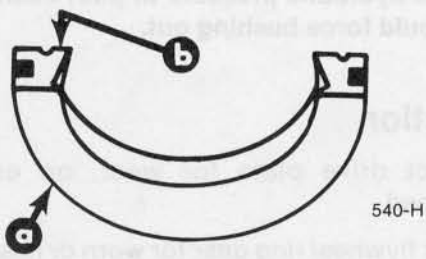
Installation

IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



a - MCM and MIE (L.H.) Rotation Engines
b - MIE (R.H.) Rotation Engines
c - Seal Lip Toward Inside of Engine
d - Rotation of Crankshaft as Viewed From Flywheel End Looking Forward

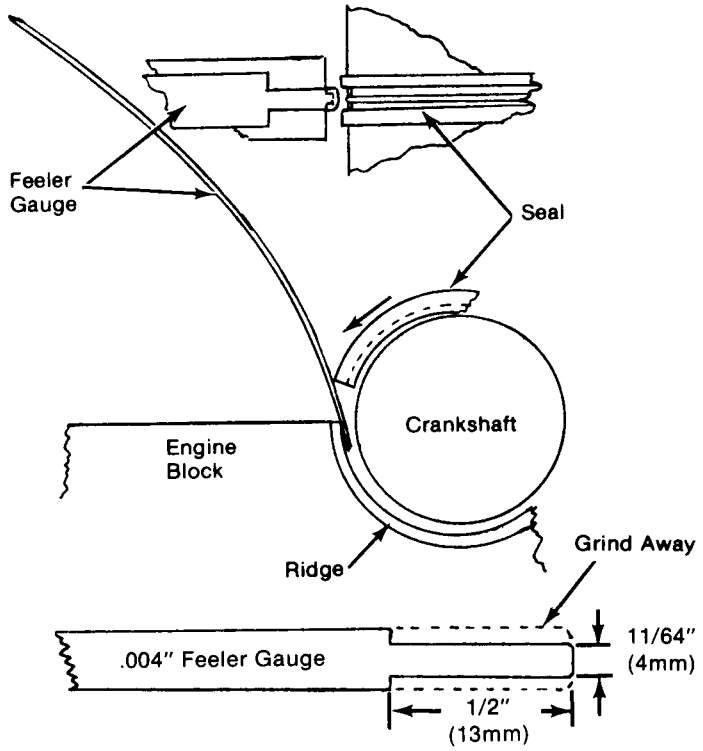
Rear Seals WITH Helical Grooves



a - Can Be Used On Any Rotation Engine
b - Seal Lip Toward Inside of Engine

Rear Seal WITHOUT Helical Grooves

Extreme care must be exercised when installing seal to prevent damage to sealing bead, located in the channel on outside diameter of the seal. To protect this bead, installation tool must be used. Construct tool using .004" (.1mm) shim stock, if tool is not supplied with seal.



Installing Rear Main Seal - Cylinder Block Inverted

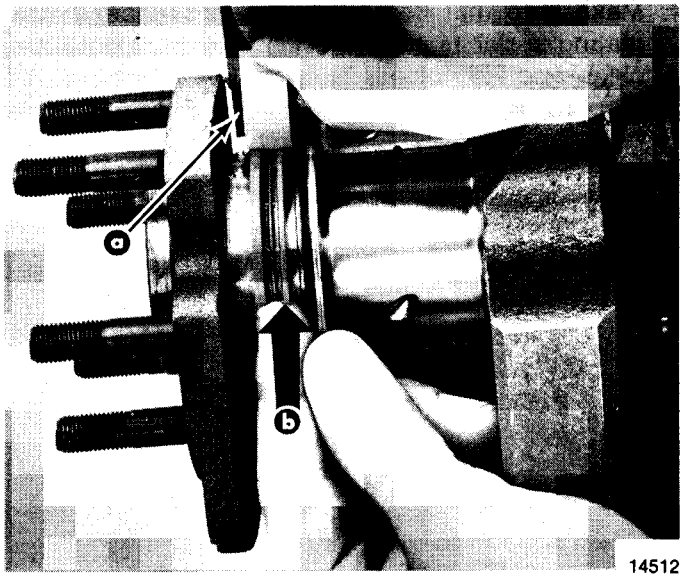
1. Coat lips and sealing bead on new rear oil seal with engine oil. Keep oil off of seal parting surfaces.

IMPORTANT: Be sure to install oil seal with lip facing toward inside of engine.

2. Install upper half of oil seal:
   a. Position tip of installation tool between crankshaft and seal seating surface in cylinder block.
   b. Position upper half of seal between crankshaft and tip of installation tool so that seal bead contacts tip of tool.
   c. Roll upper half of seal around crankshaft using installation tool as a "shoe-horn" to protect seal bead from sharp corner of seal seating surface.

IMPORTANT: Installation tool must remain in position until seal is properly positioned with both ends flush with block.

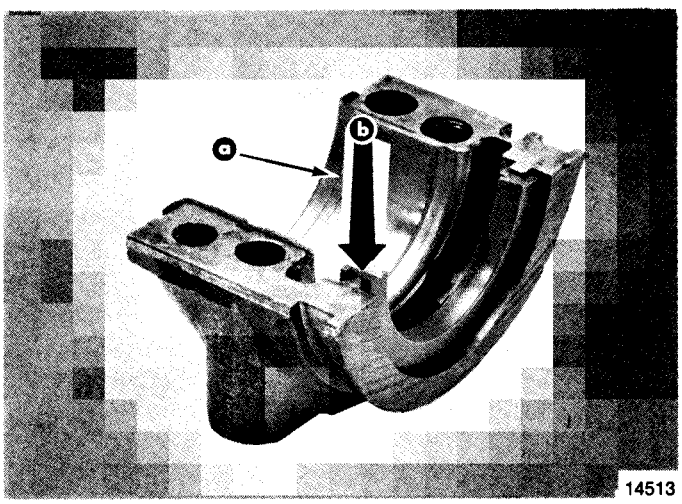
   d. After both ends of seal half are flush with block, remove installation tool.



a - Installation Tool
b - Roll Seal Into Place In This Direction

Installing Upper Half of Oil Seal

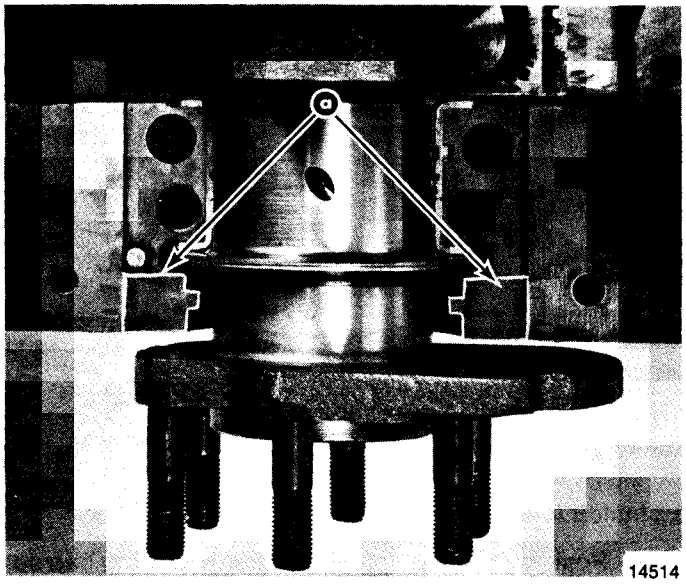
3. Install lower half of oil seal:
   a. Position oil seal half in rear main bearing cap so that one end is slightly below mating surface and seal lip is facing toward bearing. Do not allow sealing bead on other end of seal half to contact seal seating surface.
   b. Insert installation tool in between sealing bead and seal seating surface, then, using tool as a "shoe-horn" to protect sealing bead from sharp corner of seal seating surface, roll seal into place. Seal is properly positioned when both ends are flush with cap.
   c. Remove installation tool.



a - Installation Tool
b - Roll Seal Half Into Position in This Direction

Installing Lower Half of Oil Seal

4. Make sure that bearing cap and cylinder block mating surfaces and oil seal parting surfaces are clean and free of oil, then apply Perfect Seal to block at locations shown. Do not get sealer on seal parting surfaces or on surfaces adjacent to main bearing inserts.



a - Apply Perfect Seal to Outlined Area Only

Applying Sealer to Block

5. Install rear main bearing cap and torque attaching bolts to 10-12 ft. lbs. (13-16 N.m). Tap crankshaft first rearward and then forward with a lead hammer to line up rear main bearing thrust surfaces. With crankshaft in forward position, torque rear main bearing cap attaching bolts evenly (alternating from side to side) to specifications.
6. Install oil pump and oil pan as outlined.

Main Bearings

Main bearings are precision insert type and do not utilize shim for adjustment. If clearances are excessive, a new bearing (both upper and lower halves) will be required. Bearings are available in standard size and undersize. Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. Consequently, one half of a standard insert may have one half of a .001" undersize insert which will decrease clearance .0005" from using a full standard bearing.

When a production crankshaft cannot be precision fitted by this method, it then is ground .009" (.229mm) undersize on main journals only. A .009" undersize bearing and .010" undersize bearing may be used for precision fitting in the same manner as previously described. Any engine fitted with a .009" undersize crankshaft will be identified by the following markings:

- ".009" will be stamped on crankshaft counterweight forward of center main journal.
- A figure "9" will be stamped on block at left front oil pan rail.
- A crankshaft with an undersize journal will be painted with light green on each side of the affected journal.

IMPORTANT: If crankshaft has an undersize journal and a new bearing is required, journal must be reconditioned to accept a .010" or a .020" undersize bearing as .009" undersize bearings are not available for service.

Inspection

In general (except No. 2 bearing), lower half of bearing shows a greater wear and most distress from fatigue. After inspection, if lower half is suitable for use, it can be assumed that the upper half also is satisfactory. If lower half is worn or damaged, both upper and lower halves should be replaced. Never replace one half without replacing the other.

Checking Clearance

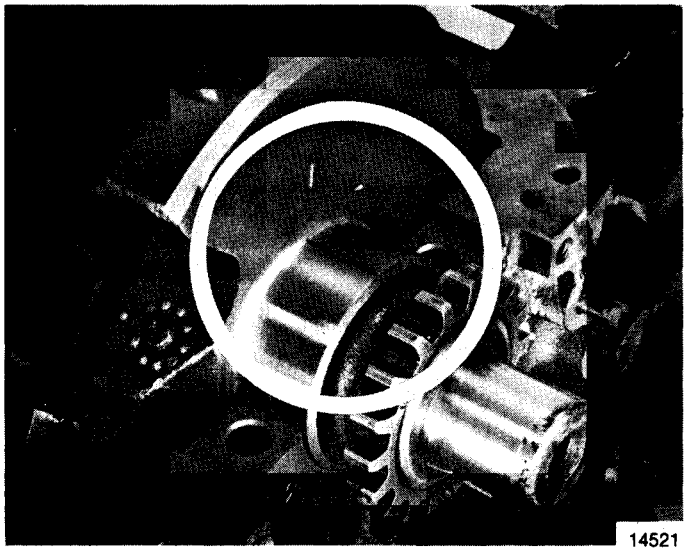
To obtain best results, use Plastigage (or its equivalent), a wax-like plastic material which will compress evenly between bearing and journal surfaces without damaging either surface. With engine upside-down, crankshaft will rest on upper bearings, and total clearance can be measured between lower bearing and journal.

IMPORTANT: To assure proper seating of crankshaft, all bearing cap bolts should be at their specified torque. In addition, surface of crankshaft journal and bearing should be wiped clean of oil before checking fit of bearings. Remove oil seal from rear main bearing cap prior to checking clearance.

1. With oil pan, baffle (some engines) and oil pump removed (starting with rear main bearing), remove bearing cap and wipe oil from journal and bearing cap.
2. Place a piece of gauging plastic full width of bearing (parallel to crankshaft) on journal.

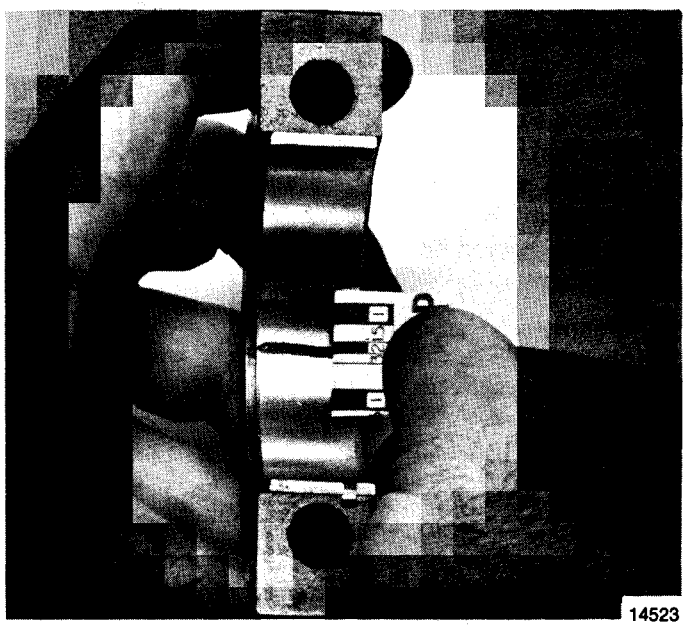
IMPORTANT: Do not rotate crankshaft while gauging plastic is between bearing and journal.

3. Install bearing cap and torque retaining bolts evenly to specifications.


14521

Gauging Plastic on Journal

4. Remove bearing cap. Flattened gauging plastic will be found adhering to either bearing shell or journal.
5. Use graduated scale (correlated in thousandths of an inch) on edge of gauging plastic envelope. Without removing gauging plastic, measure its compressed width (at widest point) with graduations on gauging plastic envelope.


14523

Measuring Gauging Plastic

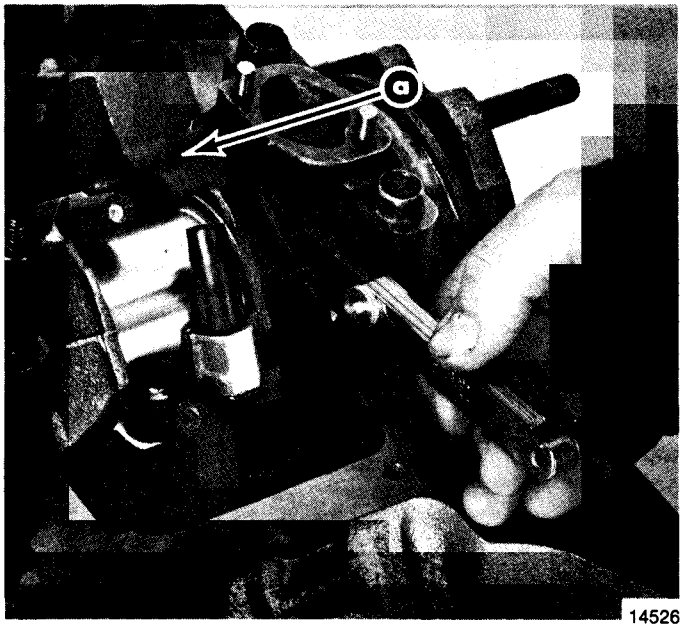
IMPORTANT: Main bearing journals usually wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal (.001" [0.25mm] maximum), be sure to fit to maximum diameter of journal. If bearing is fitted to minimum diameter, and journal is out-of-round .001", interference between bearing and journal will result in rapid bearing failure. If flattened gauging plastic tapers toward middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of bearing or journal. Be sure to measure journal with a micrometer if flattened gauging plastic indicates more than .001" difference.

6. If bearing clearance is within specifications, bearing insert is satisfactory. If clearance is not within specifications, replace the insert. Always replace both upper and lower insert as a unit.

IMPORTANT: If a new bearing cap is being installed and clearance is less than .001", inspect for burrs or nicks.

7. A standard .001" or .002" undersize bearing may produce proper clearance. If not, regrind crankshaft journal for use with next undersize bearing.
8. Proceed to next bearing. After all bearings have been checked, rotate crankshaft to see that excessive drag does not exist.

9. Install front 4 main bearing caps and torque evenly to specifications.
10. Install rear main bearing cap and torque attaching bolts to 10-12 ft. lbs. (13-16 N.m). Tap end of crankshaft first rearward and then forward with a hammer to align rear main bearing thrust surfaces. With crankshaft in forward position, torque rear main bearing attaching bolts evenly (alternating from side to side) to specifications.
11. Measure crankshaft end play with a feeler gauge by forcing crankshaft forward and measuring clearance between the front of the rear main bearing and the crankshaft. If clearance is excessive rear main bearing and/or crankshaft must be replaced.
12. Install a new rear main bearing oil seal in cylinder block and main bearing cap, as outlined.

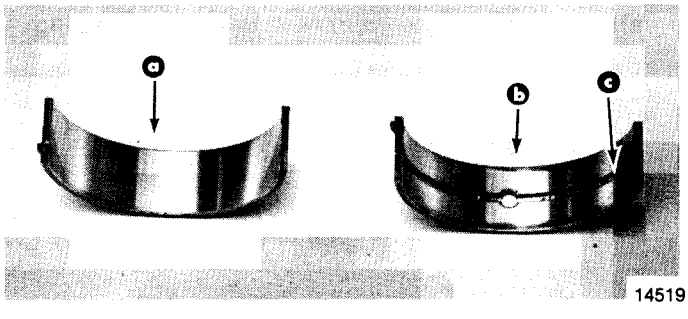


a - Force Crankshaft Forward

Measuring Crankshaft End Play

Replacement

NOTE: Main bearings may be replaced with or without removing crankshaft.



a - Lower Bearing Insert (Install in Cap)
b - Upper Bearing Insert (Install in Block)
c - Oil Groove

Main Bearing Inserts

WITH CRANKSHAFT REMOVED

1. Remove and inspect crankshaft.
2. Remove main bearings from cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in cylinder block and main bearing caps.
4. Install crankshaft.

WITHOUT CRANKSHAFT REMOVED

1. With oil pan, baffle (some engines), oil pump and spark plugs removed, remove cap on main bearing requiring replacement and remove bearing from cap.
2. Replace main bearing upper half as follows:
   a. Install main bearing removing and installing tool in crankshaft journal oil hole.

NOTE: If tool is not available, bend a cotter pin.

   b. Rotate crankshaft clockwise (as viewed from front of engine). This will roll upper bearing out of block.
   c. Oil new selected size upper bearing and insert plain (unnotched) end between crankshaft and notched side of block. Rotate bearing into place and remove tool from oil hole in crankshaft journal.
3. Oil new lower bearing and install in bearing cap.
4. Install main bearing cap with arrows pointing toward front of engine.
5. Torque main bearing cap bolts to specifications.

Connecting Rod Bearings

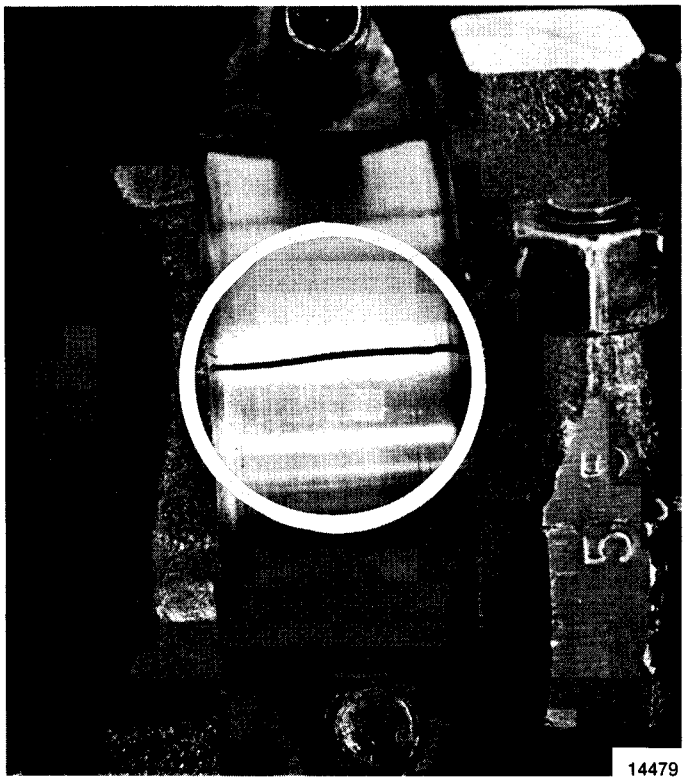
Connecting rod bearings are precision insert type and do not utilize shims for adjustment. Do not file rods or rod caps. If clearances are found to be excessive, a new bearing will be required. Bearings are available in standard size and undersize for new and used standard size crankshafts and reconditioned crankshafts.

Inspection and Replacement

1. With oil pan and oil pump removed, remove connecting rod cap and bearing.
2. Inspect bearing for wear or damage and replace unsatisfactory bearings.
3. Wipe bearings and crankpin clean of oil.
4. Measure crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition crankshaft. If within specifications, and a new bearing is to be installed, measure maximum diameter of crankpin to determine new bearing size required.
5. Measure new or used bearing clearances with Plastigage or its equivalent.

IMPORTANT: If a bearing is being fitted to an out-of-round crankpin, be sure to fit to maximum diameter of crankpin. If bearing is fitted to minimum diameter, and crankpin is out-of-round .001" (.025mm) or more, interference between bearing and crankpin will result in rapid bearing failure.

   a. Install bearing in connecting rod and cap.
   b. Place a piece of gauging plastic the full width of crankpin (parallel to crankshaft).



14479

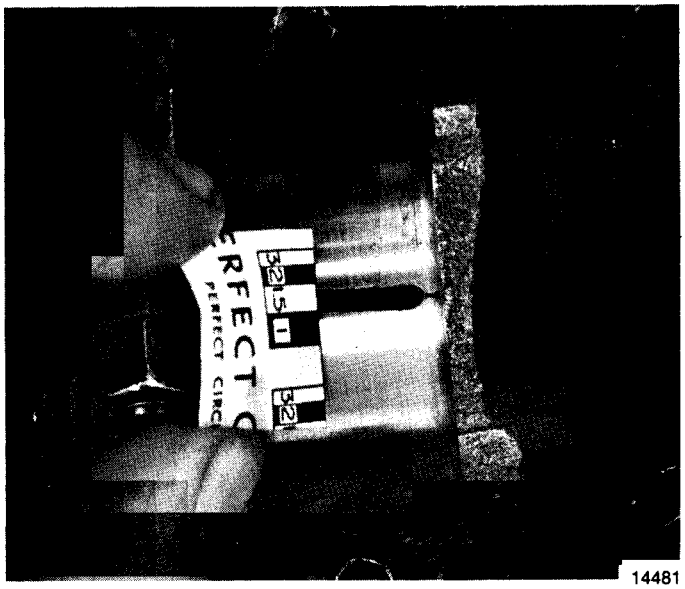
Gauging Plastic on Crankpin

   c. Install bearing cap and torque nuts evenly to specifications.

IMPORTANT: Do not turn crankshaft with gauging plastic installed.

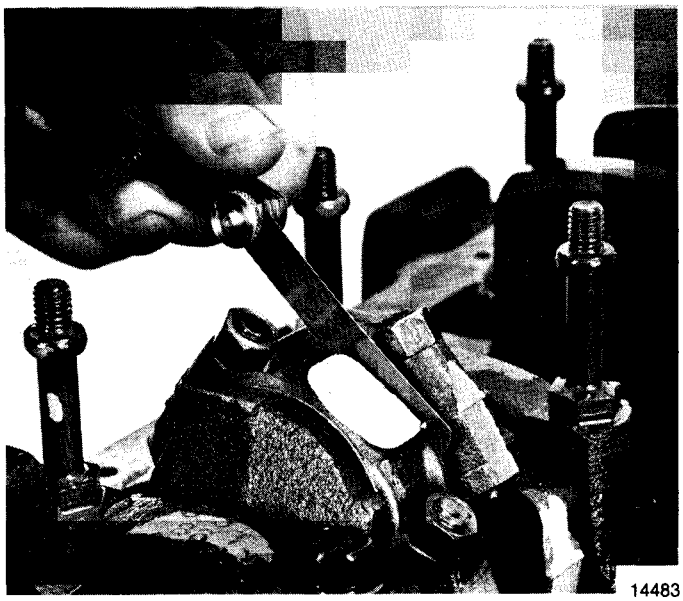
   d. Remove bearing cap and, using scale on gauging plastic envelope, measure gauging plastic width at the widest point.

6. If clearance exceeds specifications, select a new, correct size bearing and recheck clearance.
7. Coat bearing surface with oil, install rod cap and torque nuts to specifications.
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to crankpin) to make sure they have clearance.
9. Measure all connecting rod side clearances (see specifications) between connecting rod caps.



14481

Measuring Gauging Plastic



14483

Measuring Connecting Rod Side Clearance

Connecting Rod/Piston Assembly

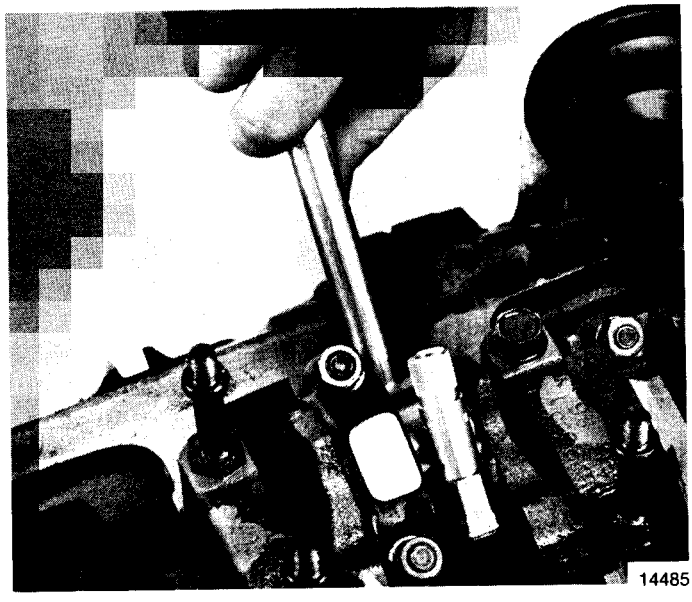
Removal

1. With oil pan, baffle (some engines), oil pump and cylinder head removed, use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

2. Mark connecting rod and bearing caps left bank 1, 3, 5 and 7; right bank 2, 4, 6 and 8 from front to rear on same side as piston thrust.
3. Remove connecting rod cap and install tool or J-6305-1 (11/32") on bolts. Push connecting rod and piston assembly out of top of cylinder block.

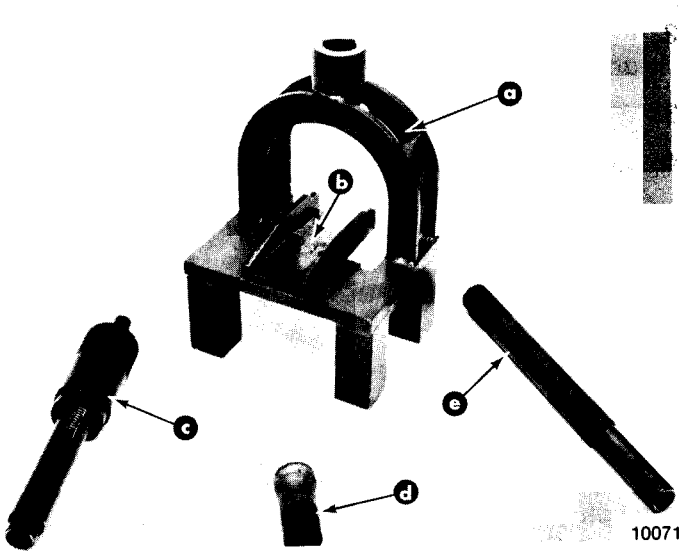
NOTE: It will be necessary to turn crankshaft slightly to disconnect and remove some connecting rod and piston assemblies.



Removing Piston Assembly

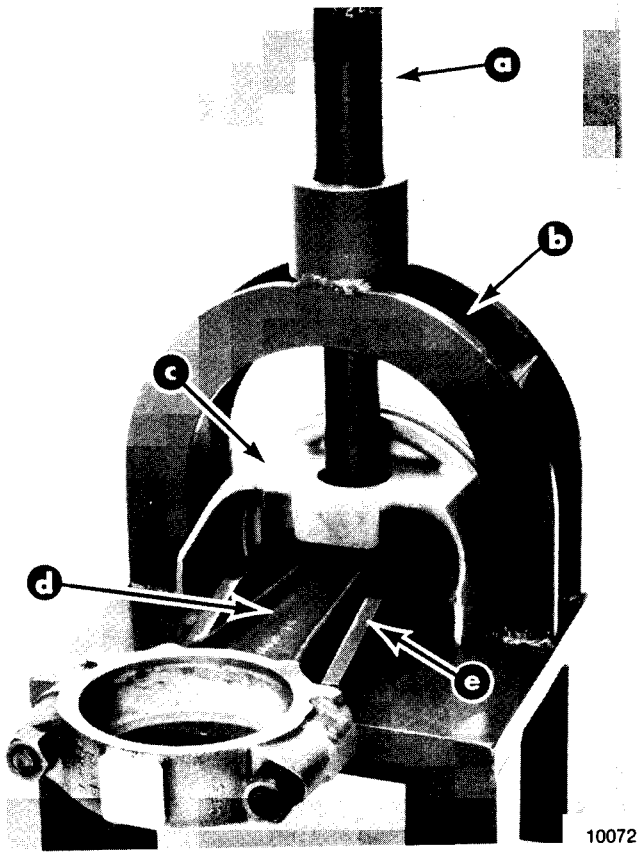
Disassembly

1. Use Tool Kit (J-24086-100).
2. Position connecting rod onto tool rod support with rod support inserted between connecting rod end and piston. Align piston pin with hole located in top of arched base.
3. Insert pin remover thru hole (located in top of arched base) and into piston pin hole. Press on pin remover to remove piston pin.



a - Arched Base
b - Rod Support
c - Adjustable Installer
d - Piston Pin Guide
e - Piston Pin Remover

Tool (J-24086-100) Parts Identification



a - Piston Pin Remover
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

Removing Piston Pin

Cleaning and Inspection

CONNECTING RODS:

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted or bent rods and inspect for nicks or cracks. Replace damaged connecting rods.

PISTONS:

1. Clean varnish from piston skirts and pins with a cleaning solvent. Do not wire brush any part of piston. Clean ring grooves with a groove cleaner and make sure oil ring holes and slots are clean.
2. Inspect piston for cracked ring lands, skirts or pin bosses, wavy worn ring lands, scuffed or damaged skirts or eroded areas at top of piston. Replace pistons which are damaged or show signs of excessive wear.
3. Inspect grooves for nicks or burrs that might cause rings to hang up.
4. Measure piston skirt and check clearance as outlined under "Piston Selection - Cylinder Block".

PISTON PINS:

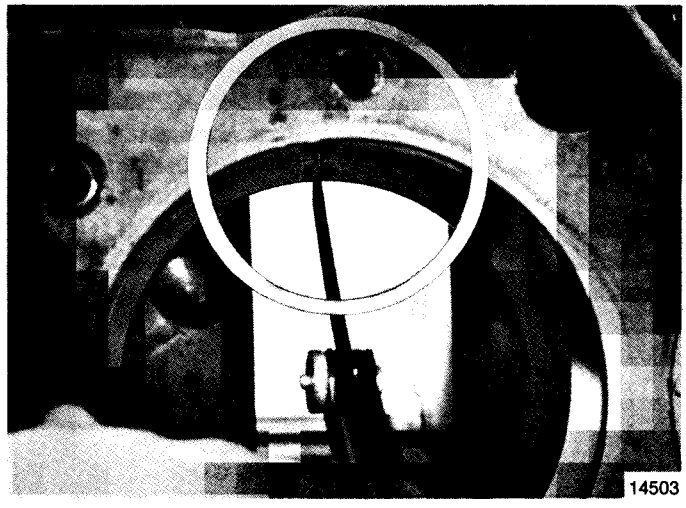
1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.
2. Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish or scuffing when measured. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of the .001" (.02mm) wear limit, replace piston and piston pin assembly.

PISTON RINGS:

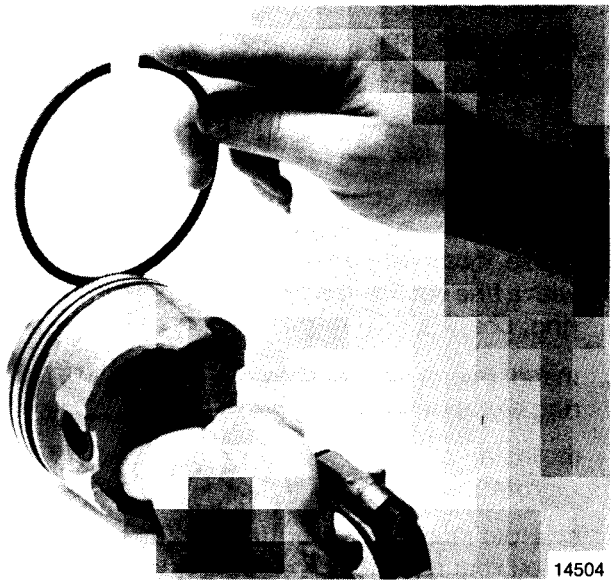
All compression rings are marked on upper side of ring. When installing compression rings, make sure that marked side is toward top of piston.

Oil control rings are a 3-piece type, consisting of 2 segments (rails) and a spacer.

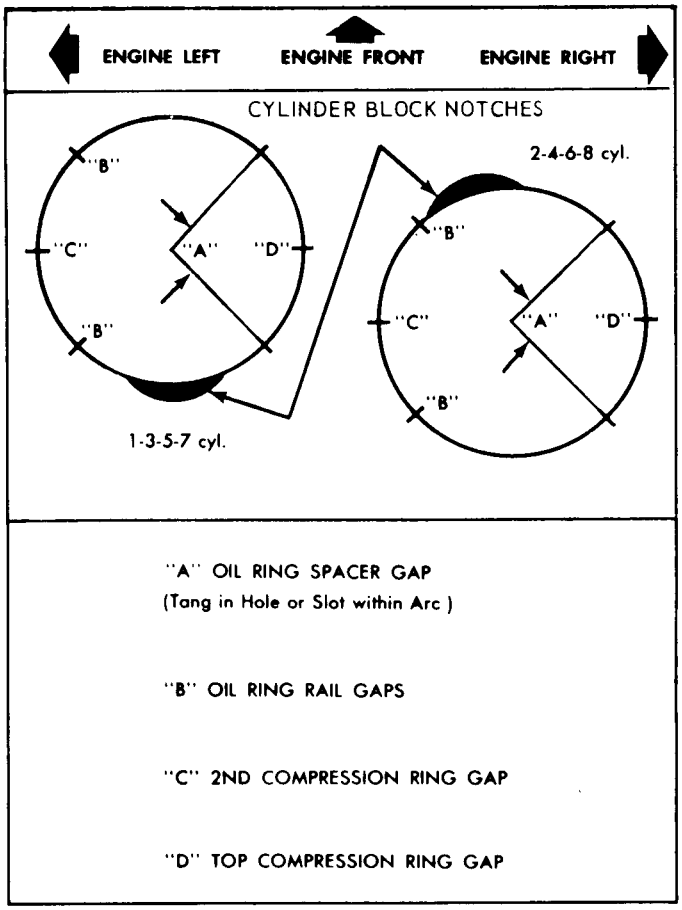
1. Select rings comparable in size to piston being used.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4" (6mm) (below ring travel). Be sure that ring is square with cylinder wall.
3. Measure space or gap between ends of ring with a feeler gauge.
4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it is going to be used.
6. Clean and inspect pistons, if not previously done.
7. Slip outer surface of top and second compression ring into respective piston ring groove and roll ring entirely around the groove to make sure that ring is free. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, check a new ring.
8. Install piston ring as shown in Use 91-24697 piston ring expanders for compression ring installation.
   a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex the oil ring assembly to make sure ring is free. If binding occurs at any point, the cause should be determined and, if caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, check a new ring.
   e. Install lower compression ring, using ring expander, and check location of gap.
   f. Install top compression ring with gap properly located.



Checking Ring Gap

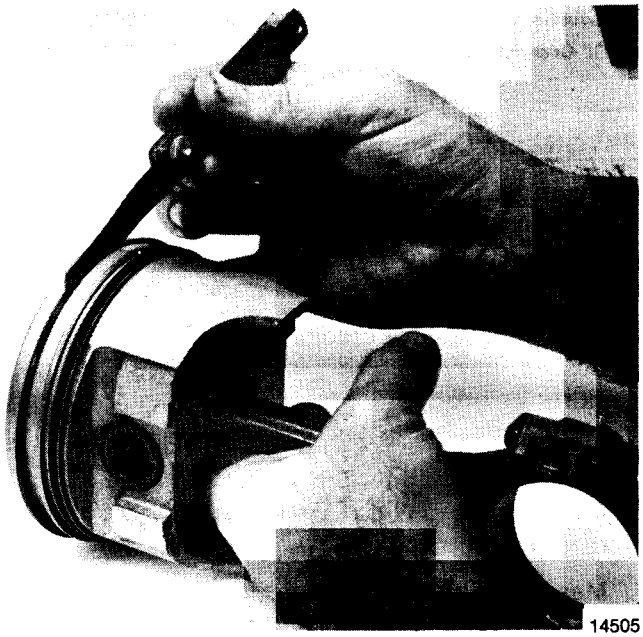


Rolling Ring in Ring Groove



Ring Gap Location

9. Proper clearance of piston ring in its piston ring groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. See "Specifications".

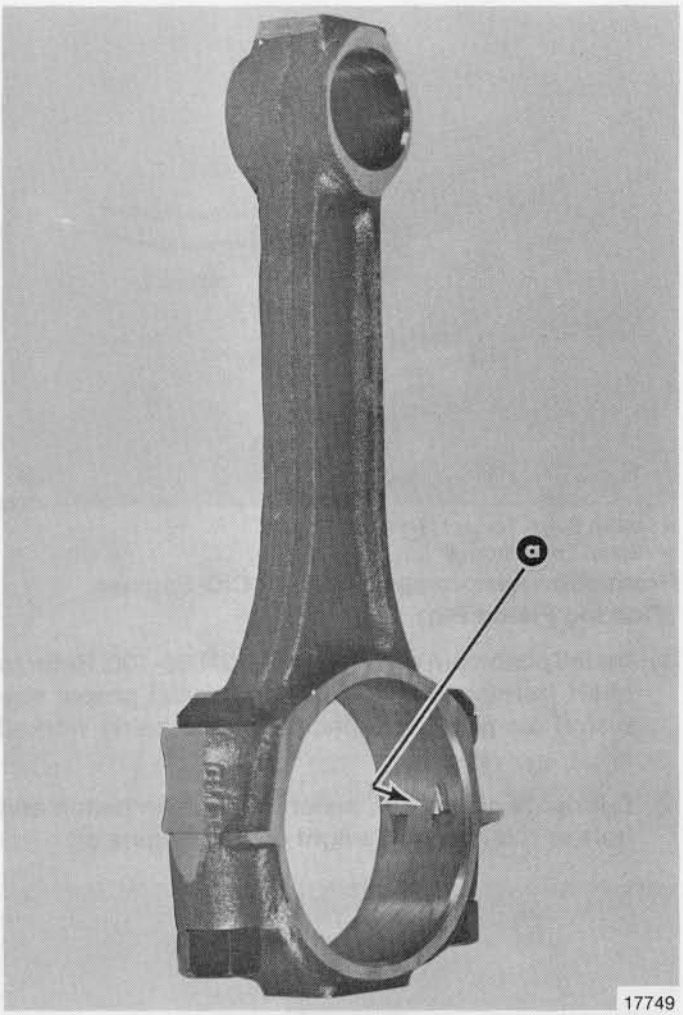


Checking Groove Clearance

Reassembly

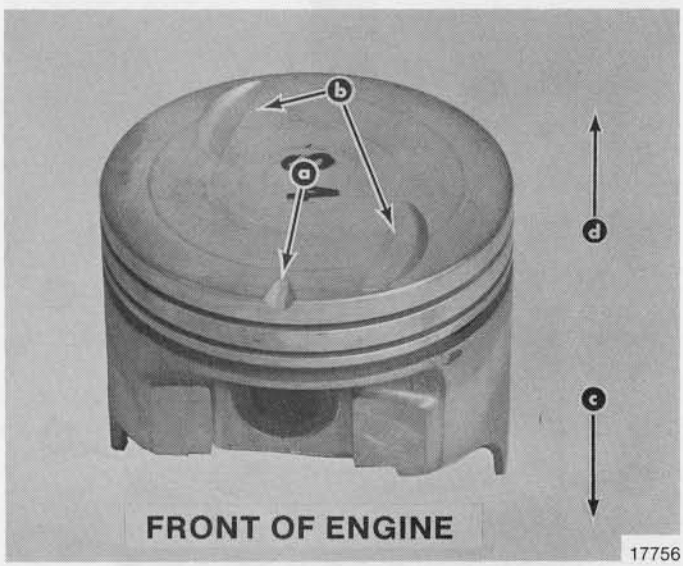
IMPORTANT: When reassembling pistons and connecting rods, the following must be kept in mind.

- **Piston and pin are machine fitted to each other and must remain together as a matched set. Do not intermix pistons and pins.**
- **If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.**
- **Connecting rod bearing tangs are always toward outside of cylinder block.**
- **Reference mark on piston, must be positioned correctly for engine that is being repaired.**
- **To determine if engine is left-hand (standard) rotation or right-hand (opposite) rotation, inspect camshaft drive. If engine has a timing chain, engine is left-hand rotation. If engine has timing gears, engine is right-hand rotation. All MCM engines are left-hand rotation.**



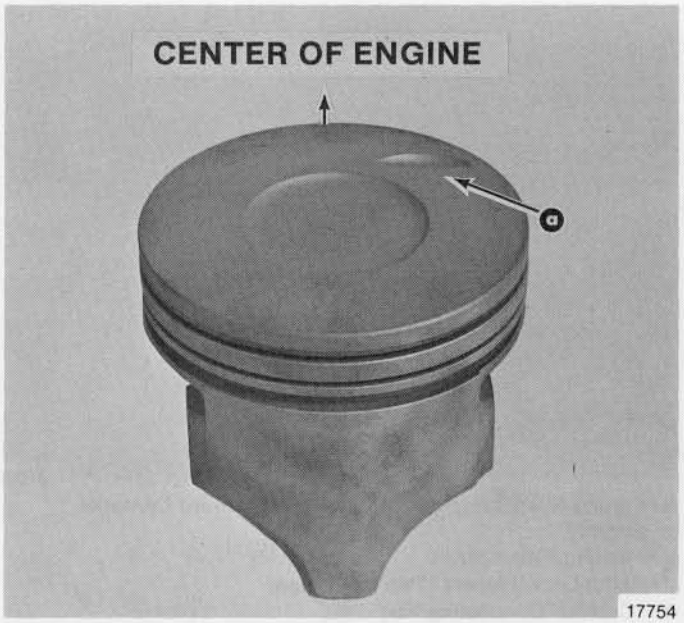
a - Connecting Rod Bearing Tangs Must Face Toward Outside of Cylinder Block

Connecting Rod



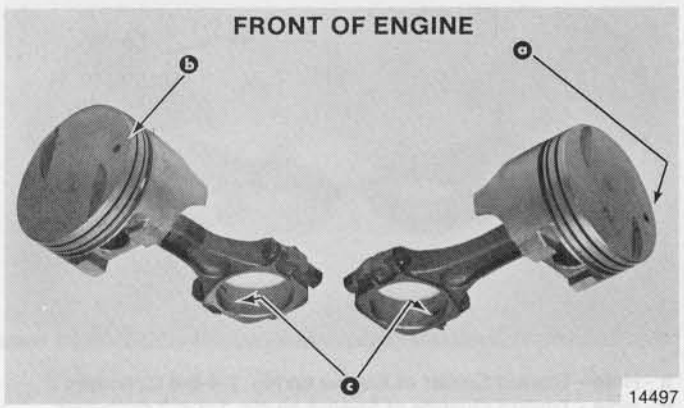
a - Notch
b - Valve Relief
c - MCM and MIE L.H. Rotation Engines - Notch Toward Front of Engine
d - MIE R.H. Rotation Engines - Notch Toward Rear of Engine

Standard 454 CID Engines



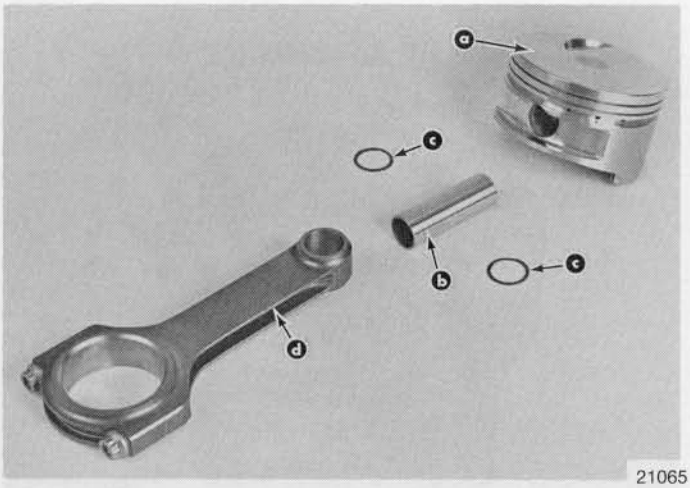
a - Valve Relief - Toward Center of Engine on MCM, MIE L.H. or MIE R.H. Engines

Standard 454 CID Engines (Sumped Piston)



a - Hole - Toward Outside of Engine on No. 2-4-6-8 Cylinders
b - Hole - Toward Center of Engine on No. 1-3-5-7 Cylinders
c - Bearing Tangs - Toward Outside of Engine

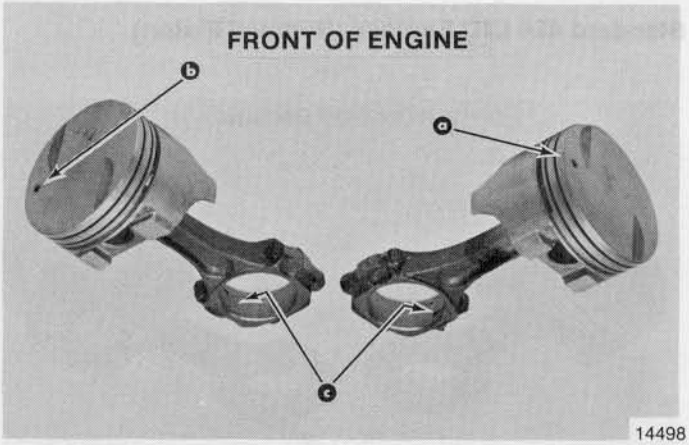
Standard 454 CID Engines, MCM and MIE L.H. Rotation Engines (Pistons with Reference Hole)



21065

a - Forged Aluminum Piston (Valve Relief Toward Center of Engine)
b - Floating Piston Pin
c - Spiral Lock Keepers (Two Per Piston)
d - "Carrillo" Connecting Rod

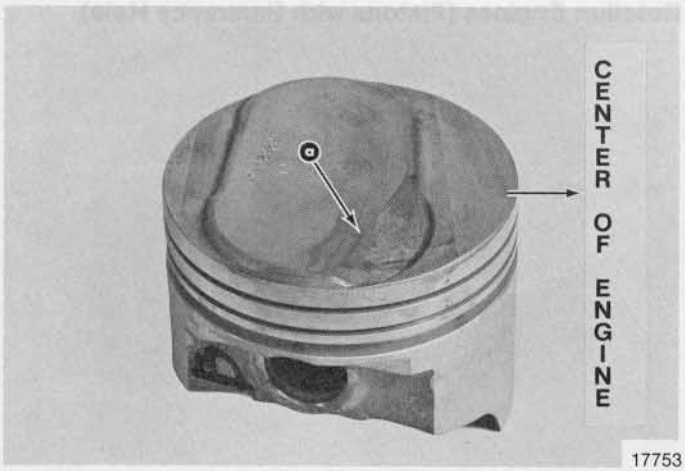
482/540 CID Production Performance Engines



14498

a - Hole - Toward Center of Engine on No. 2-4-6-8 Cylinders
b - Hole - Toward Outside of Engine on No. 1-3-5-7 Cylinders
c - Bearing Tangs - Toward Outside of Engine

Standard 454 CID Engines, MIE R.H. Rotation Engines (Pistons with Reference Hole)



17753

a - Valve Relief - Toward Center of Engine

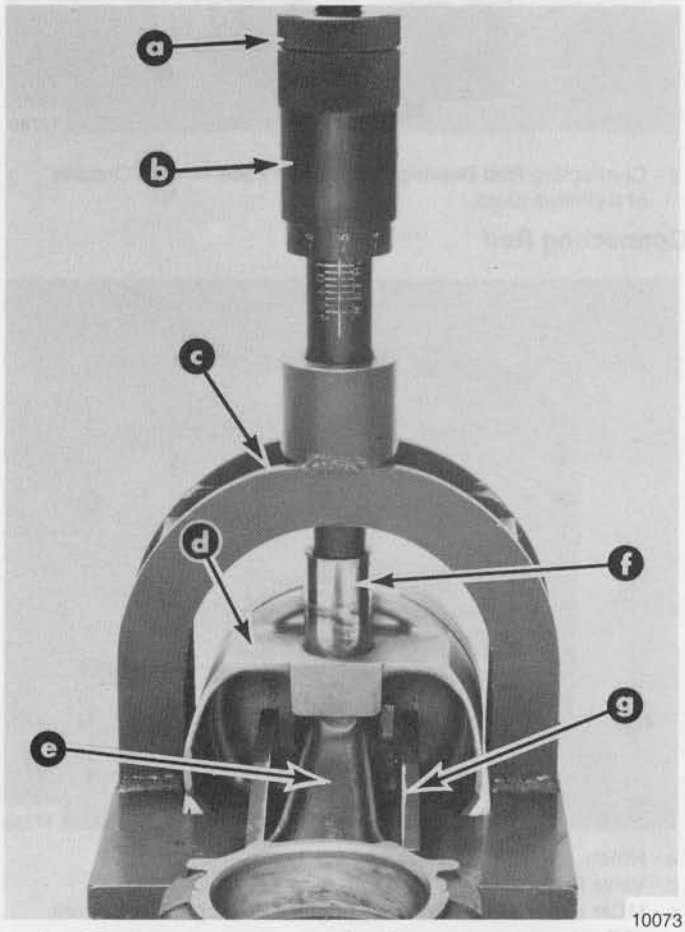
Production-Performance 454 CID Engines

21066

a - Valve Relief Toward Center of Engine
b - Spiral Lock Groove

Production Performance 482/540 CID Engines (Floating Piston Pin)

1. Install piston pin with Tool Kit J-24086-100. Refer to chart (furnished with Tool) and select proper size piston pin guide for specific engine being worked on.
2. Lubricate piston pin, piston pin hole in piston and hole in rod end with a light coat of engine oil.



10073

a - Jam Nut
b - Adjustable Installer
c - Arched Base
d - Piston
e - Connecting Rod
f - Piston Pin
g - Rod Support

Installing Piston Pin

3. Position rod onto rod support and piston onto rod end. Insert piston pin guide thru bottom piston pin hole and into connecting rod. Place piston pin thru top side of piston.
4. Adjust adjustable installer to setting specified on chart (which came with tool) for particular piston installation. Lock adjustable installer with jam nut.
5. Insert adjustable installer thru hole (located on top of arched base) and into piston pin hole. Carefully press on adjustable installer until installer bottoms-out on arched base to install piston pin.
6. Check piston for freedom of movement in piston pin bores by moving connecting rod back-and-forth and up-and-down. Connecting rod should move freely (with no resistance) in both directions. If it does not, piston pin is tight in piston pin bores and piston and pin assembly must be replaced.
7. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

Installation

IMPORTANT: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, swab bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install tool J-5239 (3/8") or J-6305-1 (11/32") on connecting rod bolts.

a - Connecting Rod Bearing Tangs Toward Outside of Cylinder Block

Connecting Rods - Installed Position

Installing Connecting Rod and Piston Assemblies

IMPORTANT: Be sure ring gaps are properly positioned as previously outlined.

4. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tangs toward outside of cylinder block. Use tool J-8307 to compress rings. Guide connecting rod into place on crankshaft journal with tool J-5239 or J-6305-1. Use a hammer handle with light blows to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3, 5 and 7 in left bank and 2, 4, 6 and 8 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.

5. Remove tool J-5239 or J-6305-1.
6. Install bearing caps and torque nuts to specification.
7. Check connecting rod side clearance.

NOTE: If bearing replacement is required, refer to "Connecting Rod Bearings".

8. Install the following items:
   a. Oil Pump
   b. Baffle (if equipped)
   c. Oil Pan
   d. Cylinder Head
9. Install engine in boat.
10. Fill crankcase with oil.
11. Start engine, adjust timing and check for leaks.

Crankshaft

Removal

1. Remove engine from boat.
2. Drain coolant and crankcase oil. Disconnect all hoses.
3. Remove starter motor, flywheel housing and flywheel. Place engine in repair stand.
4. Remove belts, crankshaft pulley and water pump.
5. Remove torsional damper and crankcase front cover.
6. Remove spark plugs.
7. Remove camshaft sprocket and timing chain. (Left-hand rotation engines only.)
8. Remove oil pan and oil pump.
9. Make sure all bearing caps (main and connecting rods) are marked so they can be installed in their original locations.
10. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.
11. Remove main bearing caps and carefully lift crankshaft out of cylinder block. Remove rear main bearing oil seal from cylinder block and rear main bearing cap.
12. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings following procedures outlined in this section. (See "Index".)

Cleaning and Inspection

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize (see "Specifications").
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in "V" blocks) and check at front and rear intermediate journals with a dial indicator (see "Specifications").
4. Replace or recondition crankshaft if not meeting specifications.

Installation

1. If a new crankshaft is being installed, proceed as follows:
   a. Remove timing sprocket or gear from old crankshaft and reinstall on new crankshaft.
   b. **OnI-Drive Engines:** Remove flywheel attaching studs from old crankshaft, using heat if necessary. Reinstall studs in new crankshaft with Loctite 35 applied to threads.

IMPORTANT: Be sure that all bearings and crankshaft journals are clean.

2. Install a new rear main bearing oil seal in cylinder block and rear main bearing cap.
3. Carefully lower crankshaft into place. Be careful not to damage bearing surface.
4. Check clearance of each main bearing, following procedure outlined under "Main Bearing"; see "Index". If bearing clearances are satisfactory, apply a light coat of engine oil to journals and bearings.
5. Install all bearing caps and bolts. Torque all main bearing cap bolts to specifications. When tightening rear main bearing cap. Follow procedure outlined under "Main Bearing"; see "Index".
6. Check clearance for each connecting rod bearing, following procedure under "Connecting Rod Bearings"; see "Index". If bearing clearances are satisfactory, apply a light coat of engine oil to journals and bearings.

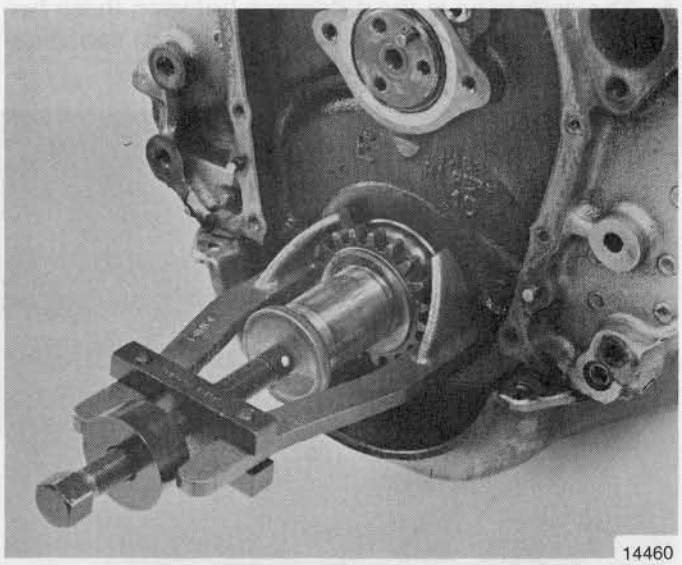
7. Install all rod caps and torque nuts to specifications.
8. Check crankshaft end play. Follow procedure outlined under "Main Bearing"; see "Index".
9. Install oil pump and pan as outlined.
10. Install camshaft sprocket and timing chain. (Left-hand rotation engines only.)
11. Install crankcase front cover and torsional damper.
12. Remove engine from repair stand and install water pump.
13. Install crankshaft pulley and belts.
14. Install spark plugs.
15. Install engine in boat, fill crankcase and install hoses.

Crankshaft Sprocket/Gear

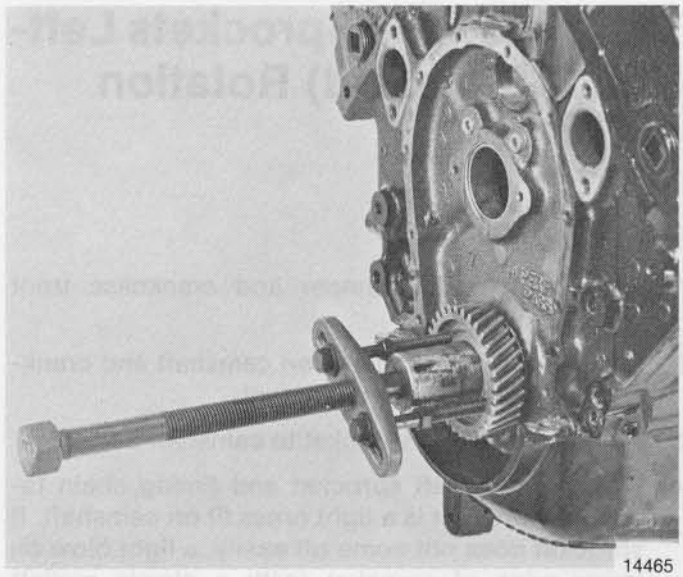
Removal

1. Remove torsional damper and crankcase front cover as outlined.
2. Remove camshaft timing chain as outlined.
3. Using tool shown in chart, remove sprocket or gear.

Left Hand Rotation Engine	J-1619
Right Hand Rotation Engine	J-8105



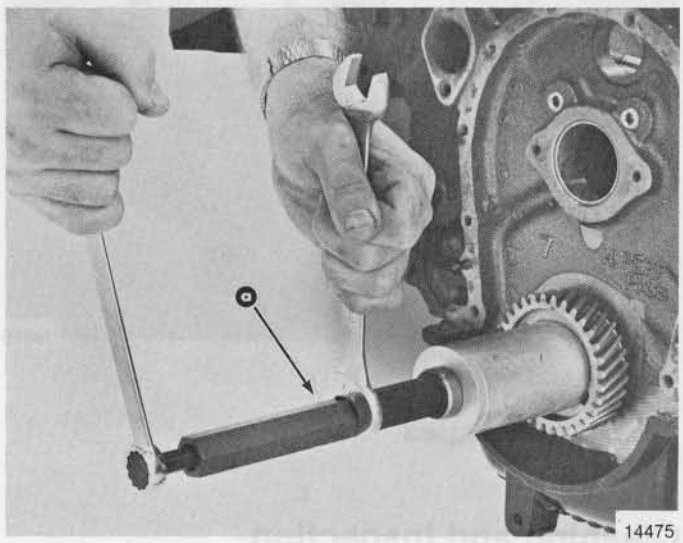
J-1619 Puller



J-8105 Puller

Installation

1. Using correct tool as shown, install sprocket or gear.
2. Install camshaft timing chain as outlined.
3. Install crankcase front cover and torsional damper as outlined.

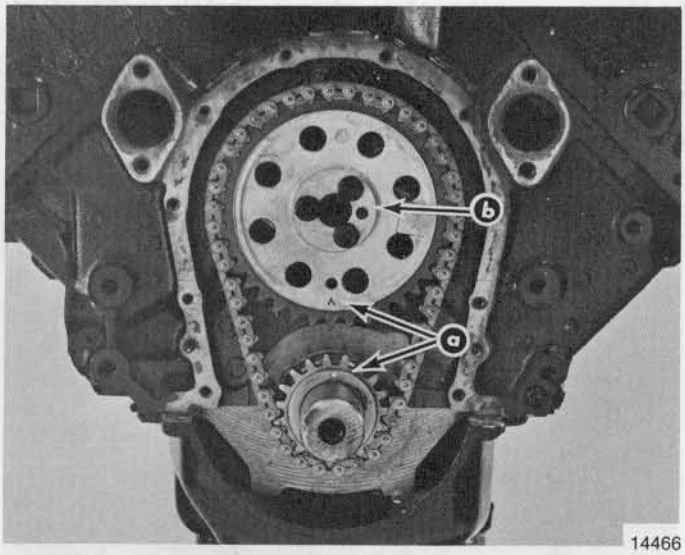


a - Tool J-21058-20

Timing Chain/Sprockets Left-Hand (Standard) Rotation Engines

Removal

1. Remove torsional damper and crankcase front cover as outlined.
2. Crank engine until marks on camshaft and crankshaft sprockets are in alignment.
3. Remove camshaft sprocket to camshaft bolts.
4. Remove camshaft sprocket and timing chain together. Sprocket is a light press fit on camshaft. If sprocket does not come off easily, a light blow on lower edge of sprocket (with a plastic mallet) should dislodge the sprocket.
5. If crankshaft sprocket has to be replaced, remove as outlined in "Crankshaft Sprocket/Gear".



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a - Timing Marks Aligned
b - Locating Pin

Timing Marks Aligned

Cleaning and Inspection

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing chain for wear or damage.
3. Inspect sprockets for wear or damage.

Installation

1. If crankshaft sprocket was removed, install as outlined in "Crankshaft Sprocket/Gear".
2. Install timing chain on camshaft sprocket. Hold sprocket vertical with chain hanging down and orient to align marks on camshaft and crankshaft sprockets.

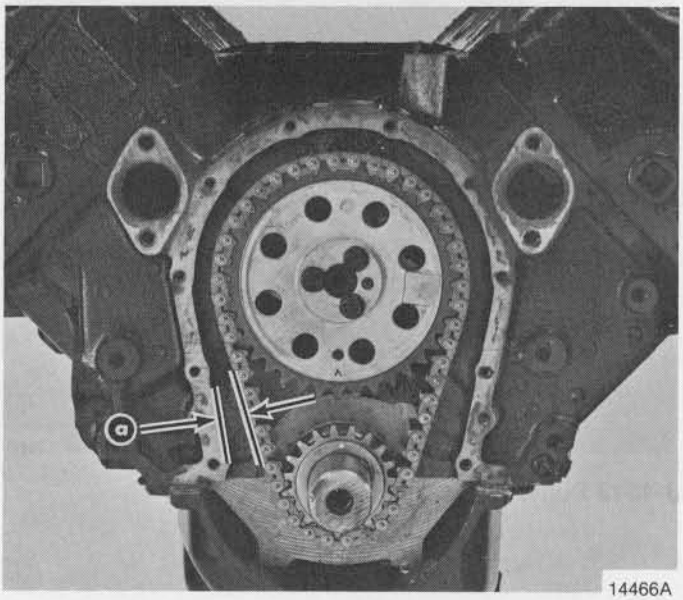
IMPORTANT: Do not attempt to drive sprocket on camshaft, as welsh plug at rear of engine can be dislodged.

3. Draw camshaft sprocket onto camshaft, using the 3 mounting bolts. Torque to specifications.
4. Lubricate timing chain with engine oil. Install crankcase front cover and torsional damper as outlined.

Checking Timing Chain Deflection

With timing chain and sprockets installed, check timing chain deflection, as follows:

1. Rotate camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.
4. The deflection is the difference between these two measurements. If the deflection exceeds specifications, timing chain should be replaced.



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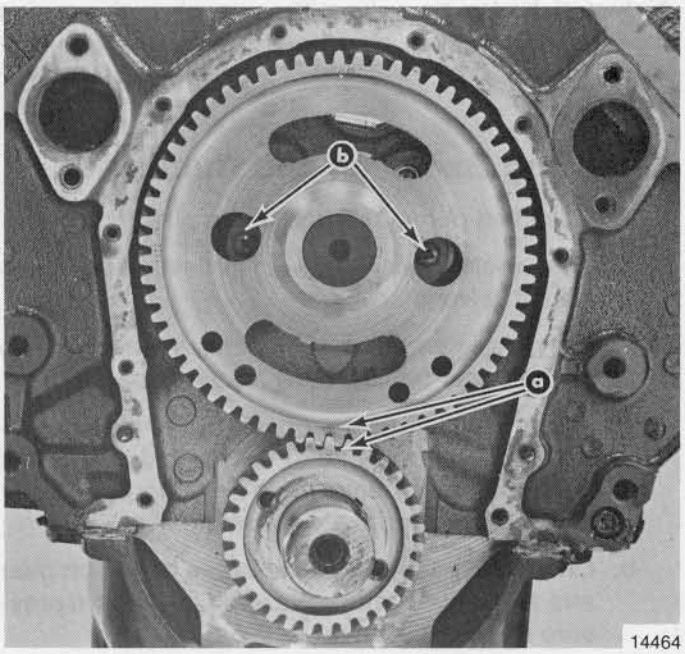
a - Reference Point

Checking Timing Chain Deflection

Timing Gears Right-Hand Rotation

Removal

1. Remove crankcase front cover.
2. Crank engine over until timing mark on camshaft gear aligns with timing mark on crankshaft timing gear.



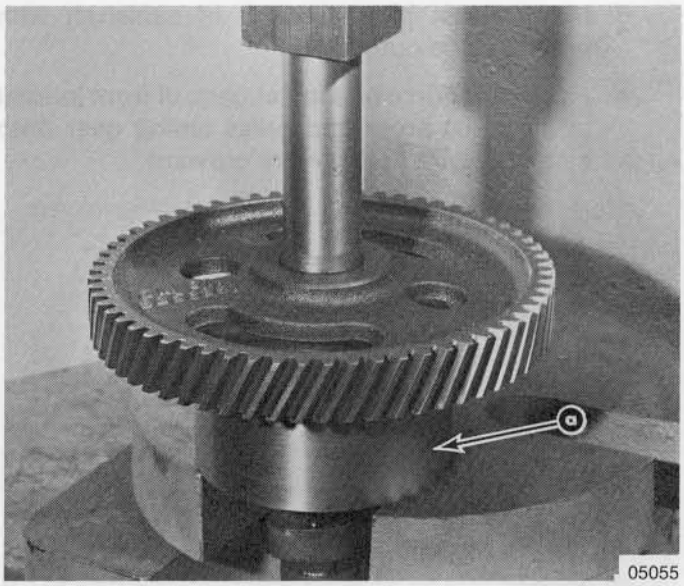
a - Timing Marks
b - Thrust Plate Attaching Screws

Timing Marks Aligned

3. Remove camshaft timing gear attaching screws through holes in timing gear.

IMPORTANT: Use extreme care when removing camshaft (in next step) to prevent damaging camshaft bearings. All camshaft journals are the same size.

4. To remove camshaft and gear as an assembly, refer to "Camshaft" (see "Index").
5. If camshaft, timing gear or thrust plate requires replacement, press gear off of camshaft, using an arbor press and appropriate tools as shown. Be sure to use a support under gear to prevent pressing on thrust plate. If camshaft is to be replaced, remove (and discard) woodruff key from camshaft and remove spacer ring.



a - Support (Must Clear Thrust Plate)

Removing Camshaft Gear

6. If crankshaft timing gear requires replacement, remove as outlined in "Crankshaft Sprocket/Gear", (see "Index").

Cleaning and Inspection

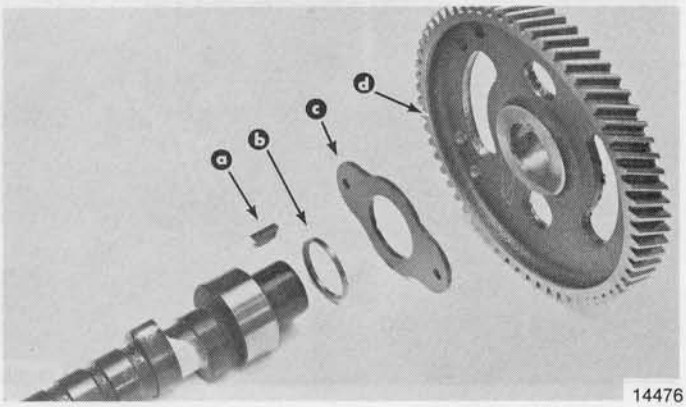
1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing gears for worn or damaged teeth.

Installation

1. If removed, install crankshaft timing gear as outlined in "Crankshaft Sprocket/Gear".
2. If removed, install spacer ring, woodruff key, thrust plate and timing gear on camshaft, as follows:
   a. Check mating surface on camshaft and timing gear to ensure that they are clean and free of burrs.
   b. Install spacer on camshaft with chamferred side toward camshaft.
   c. Install new woodruff key.

d. Place thrust plate on end of camshaft with grooved side outward.

e. Firmly support camshaft at back of front journal in an arbor press and press timing gear onto camshaft with timing mark outward.



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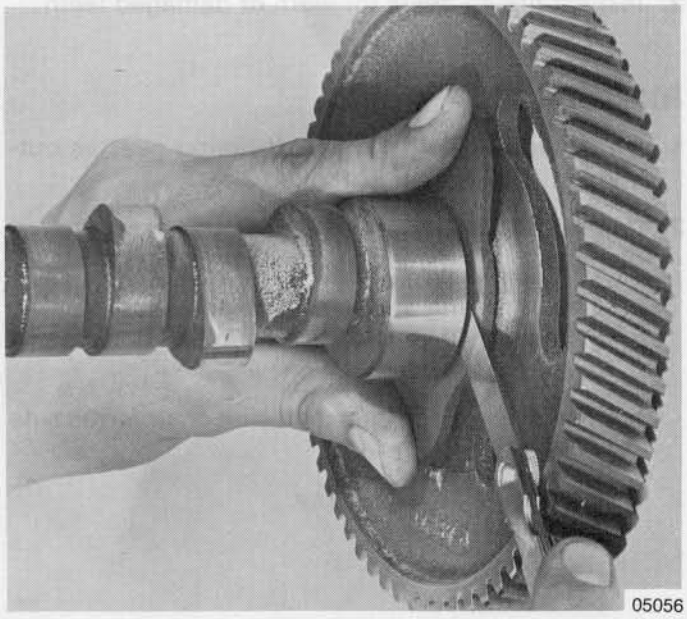
a - Woodruff Key
b - Spacer Ring
c - Thrust Plate
d - Timing Gear

Installing Camshaft Timing Gear and Related Parts

f. Check camshaft front journal to thrust plate clearance (end play) with feeler gauge. If clearance is not as specified, make sure gear is pressed on all the way. Also check thrust plate and camshaft for excessive wear and replace as required.



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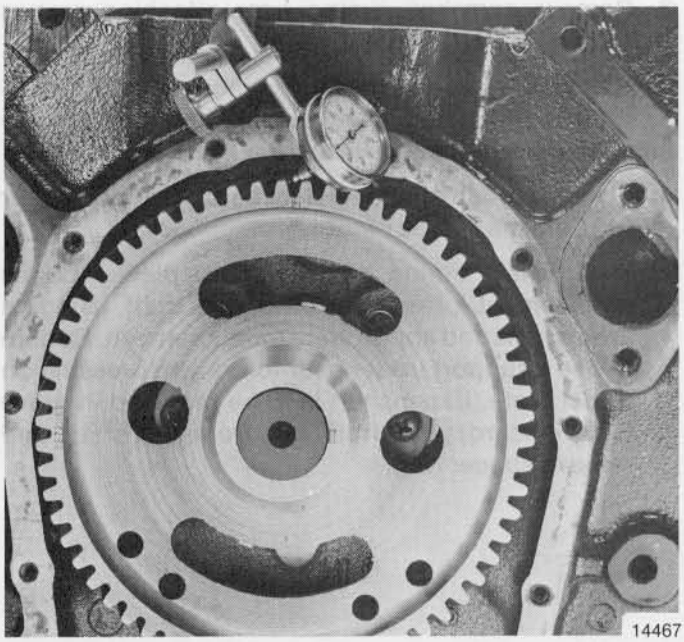
Checking End Play

3. Lubricate camshaft journals with engine oil and install camshaft being sure to align timing marks.
4. Install thrust plate attaching screws and torque to specifications.
5. Check timing gear backlash and runout as explained under "Checking Backlash and Runout".
6. Lubricate timing gears with engine oil.
7. Install crankcase front cover and torsional damper, as explained.
8. Install hydraulic valve lifters, push rods, rocker arms and rocker arm covers as previously explained.

Checking Backlash and Runout

1. Remove fuel pump and fuel pump push rod.
2. Loosen rocker arm nuts (to relieve tension on hydraulic valve lifters).
3. With timing gears installed, check camshaft to crankshaft gear backlash, as follows:
   a. Mount a dial indicator on engine so that indicator stem contacts one of the teeth on camshaft gear. Indicator stem should be as perpendicular to gear tooth surface as possible.
   b. Check the backlash between the camshaft gear and crankshaft gear while applying inward pressure on camshaft gear.
   c. If backlash is not within specifications, check for improperly machined parts or for worn camshaft or crankshaft bearings. If bearings check out good, replace both timing gears.



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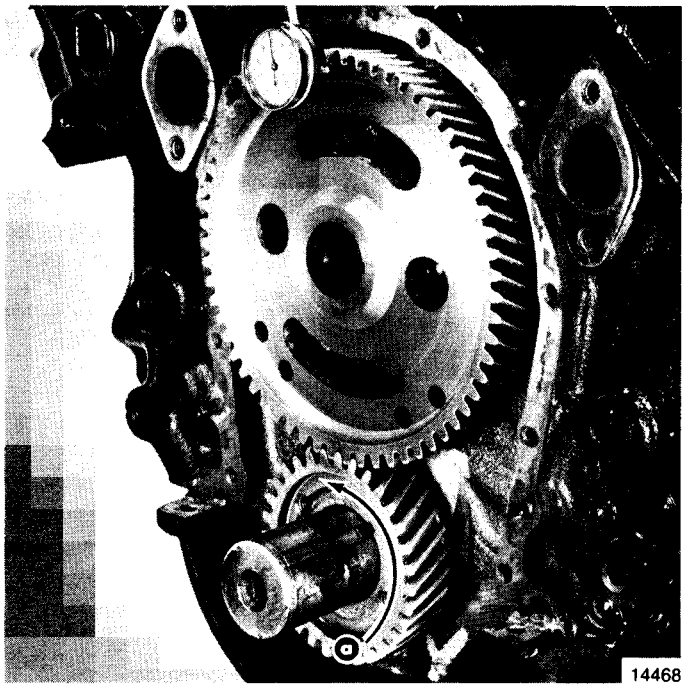
Checking Backlash

4. With timing gear installed, check camshaft and crankshaft timing gear runout, as follows:



a - Turn Crankshaft In This Direction

Checking Gear Runout

   a. Mount dial indicator on block so that indicator stem is perpendicular to camshaft timing gear and contacts gear surface just adjacent to teeth.
   b. Apply outward pressure on timing gear and zero indicator, then turn crankshaft as shown. Check gear runout through one complete revolution of camshaft gear.
   c. If not within specifications, check for burrs or foreign material between gear and camshaft joining surfaces. If none is found, replace both timing gears.
   d. Check crankshaft timing gear runout in same manner. Runout should not exceed specifications. Replace both gears, if runout is excessive.

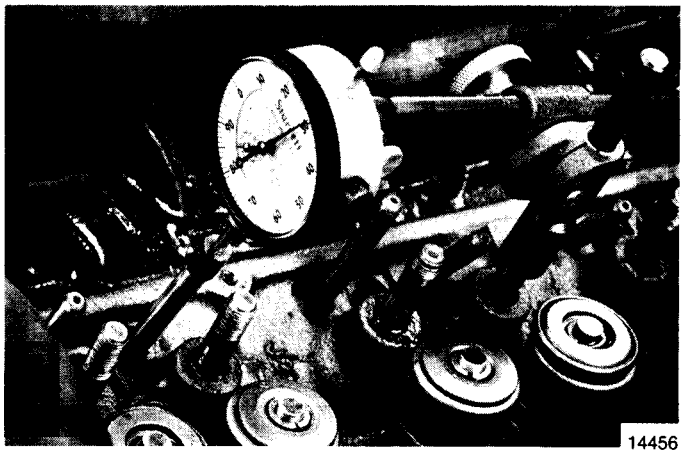
5. Adjust rocker arm nuts.
6. Install fuel pump push rod and fuel pump.

Camshaft

Measuring Lobe Lift

NOTE: Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.

1. Remove valve mechanism as outlined.
2. Position indicator with ball socket adapter Tool J-8520-1 on push rod. Be sure that push rod is in lifter socket.
3. Rotate crankshaft damper slowly in direction of rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
4. Set dial indicator on zero, then rotate balancer slowly (or attach an auxiliary starter switch and "bump" engine over) until push rod is in fully raised position.
5. Compare total lift, recorded from dial indicator, with "Specification".
6. Continue to rotate engine until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install and adjust valve mechanism as outlined.



Measuring Camshaft Lobe Lift

Removal

1. Remove valve lifters as outlined.
2. Remove crankcase front cover as outlined.
3. Remove fuel pump and fuel pump push rod.
4. Remove camshaft as follows:

MCM and MIE L.H. Rotation Engines:

a. Refer to "Timing Chain/Sprockets, Left-Hand (Standard) Rotation Engines" to remove chain and sprocket.

b. Install two 5/16-18 bolts in camshaft sprocket bolt holes and carefully remove camshaft.

MIE R.H. Rotation 454 CID Engines:

a. Refer to "Timing Gears, Right-Hand (Opposite) Rotation Engines" to remove thrust plate attaching screws.

b. Carefully remove camshaft and timing gear.

c. Remove timing gear as outlined.

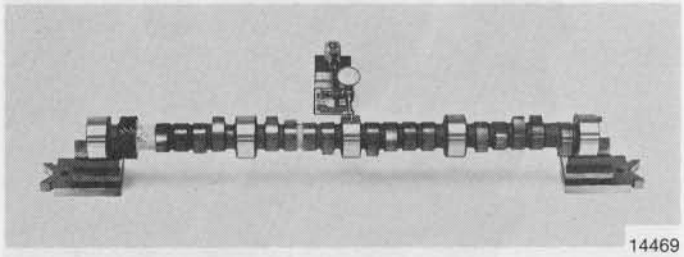
Removing Camshaft

Inspection

Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001" (.025mm) out-of-round, camshaft should be replaced.

Also check camshaft for alignment with "V" blocks and dial indicator which indicates exact amount camshaft is out-of-true. If out more than .002" (.051mm) (dial indicator reading) camshaft should be replaced.

On engines with timing gears, inspect camshaft gear and thrust plate for wear or damage.



Checking Camshaft Alignment

Installation

1. Install camshaft as follows:

MCM and MIE L.H. Rotation Engines:

a. Install two 5/16-18 bolts in camshaft bolt holes, then lubricate camshaft journals with engine oil and install camshaft, being careful not to damage bearings. Remove the two 5/16-18 bolts.

b. Install timing chain and sprocket as outlined in "Timing Chain/Sprockets, Left-Hand (Standard) Rotation Engines".

MIE R.H. Rotation Engines:

a. If removed, press timing gear onto camshaft as outlined in "Timing Gears, Right-Hand (Opposite) Rotation Engines".

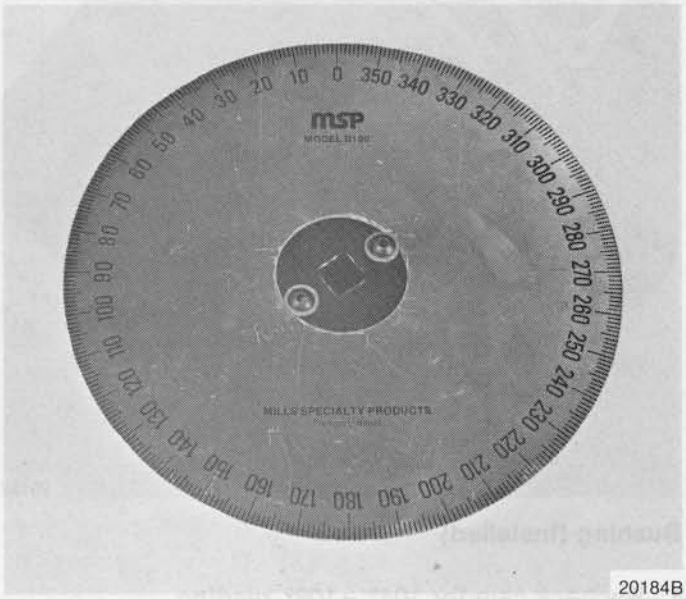
b. Lubricate camshaft journals with engine oil and install camshaft and timing gear, as outlined, being careful not to damage bearings.

2. Lubricate camshaft drive system with engine oil.
3. Install fuel pump push rod and fuel pump.
4. Install crankcase front cover and valve lifters as outlined.

Camshaft Degreeing (440/460 Cyclone)

There are various methods of degreeing camshafts. The method described in this manual is most widely used and recommended by Mercury Marine.

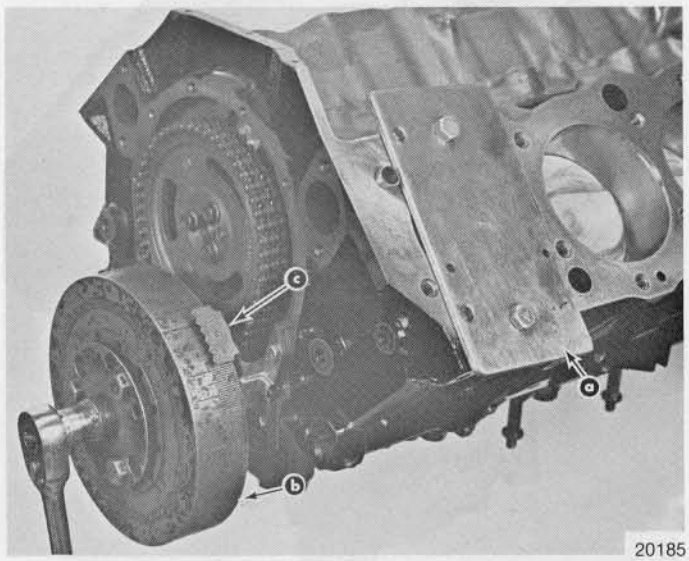
1. Install stock crankshaft balancer and timing tab or use a degree wheel and fabricated pointer.



20184B

Degree Wheel

2. Find Top Dead Center (TDC) of piston travel, two methods used;
   a. Use dial indicator on number one piston.
   b. Mount a fabricated plate on number one cylinder deck.



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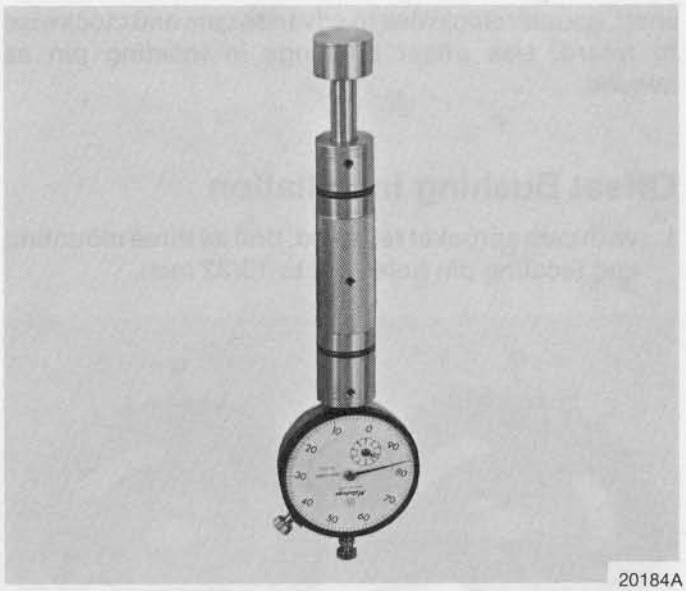
a - Plate
b - Balancer
c - Timing Tab

Rotate engine clockwise until piston hits plate. Mark on balancer/degree wheel where "O" on timing tab or pointer stopped. Rotate engine counterclockwise until piston hits plate. Mark on balancer/wheel again. Mark halfway between the two marks on the balanced wheel is TDC.

3. Install timing tape on balancer with TDC aligned with "O" of timing tab or adjust degree wheel to align "O" with pointer.

NOTE: Turn crankshaft the same direction as engine rotation.

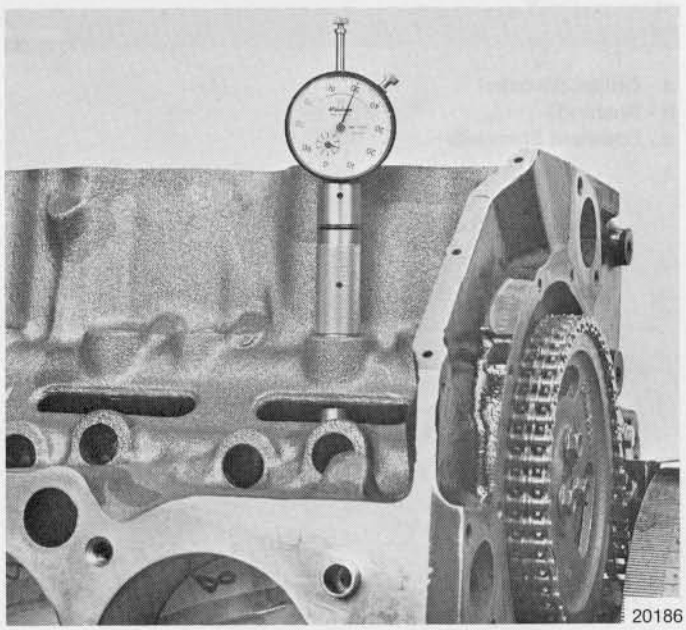
4. Locate maximum lift on number one intake lobe. Use solid lifter or MSP tool with dial indicator. Zero Dial Indicator.



20184A

MSP Cam-Check (Dial Indicator Installed)

5. Rotate crankshaft to .050 BEFORE maximum lift. Record the degrees at the timing tab/pointer.



20186

MSP Tool (Installed)

6. Rotate crankshaft to .050 AFTER maximum lift. Subtract this reading from 180° and record.
7. ADD the before and after degrees from Steps 5 and 6.
8. Divide the degrees from Step 7 by two. Answer should come out to 104° - 106°.

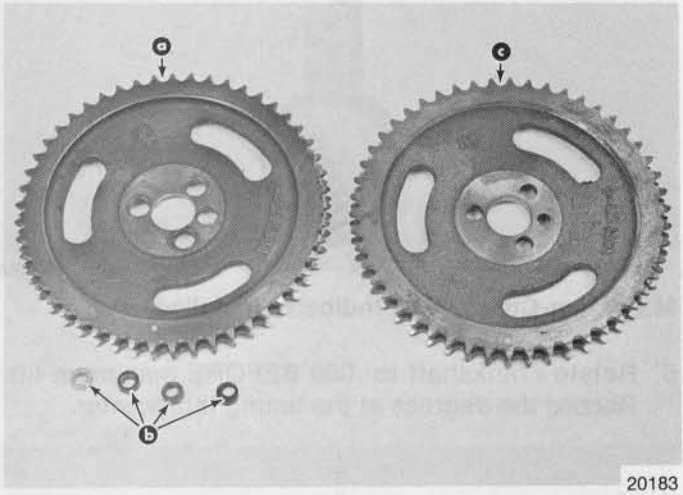
Formula

$$\frac{\text{(Degrees @ .050 before max. lift) + (180° - Degrees @ 050 after max. lift)}}{2}$$

NOTE: If degrees are less than 104° cam is advanced. If degrees are more than 106° cam is retarded. To get correct degrees move cam sprocket in relation to camshaft, counterclockwise to advance cam and clockwise to retard. Use offset bushings in locating pin as needed.

Offset Bushing Installation

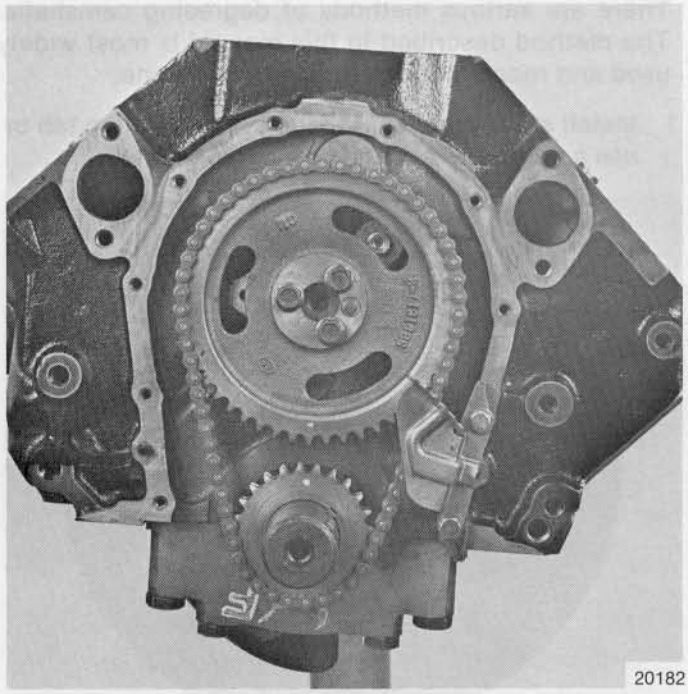
1. With cam sprocket removed, drill all three mounting and locating pin holes out to 13/32 inch.



20183

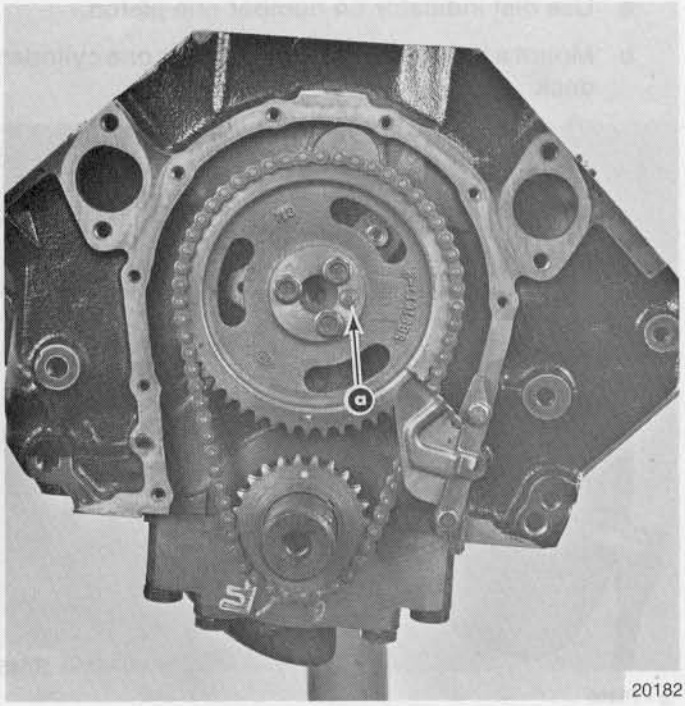
a - Drilled Sprocket
b - Bushings
c - Standard Sprocket

2. Install needed bushing in locating pin hole.
3. Assemble sprocket and chain on cam.


20182

Bushing (Installed)

4. Recheck cam for 104° - 106° reading.
5. Torque mounting bolts to specifications.
6. Center punch three spots between bushing and sprocket.



20182

a - Center Punch Here

Camshaft Bearings

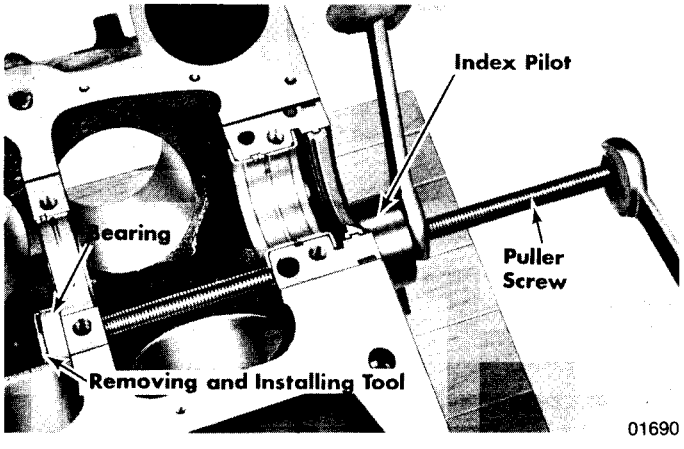
Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Fasten connecting rod against sides of engine so that they will not interfere while replacing camshaft bearings.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

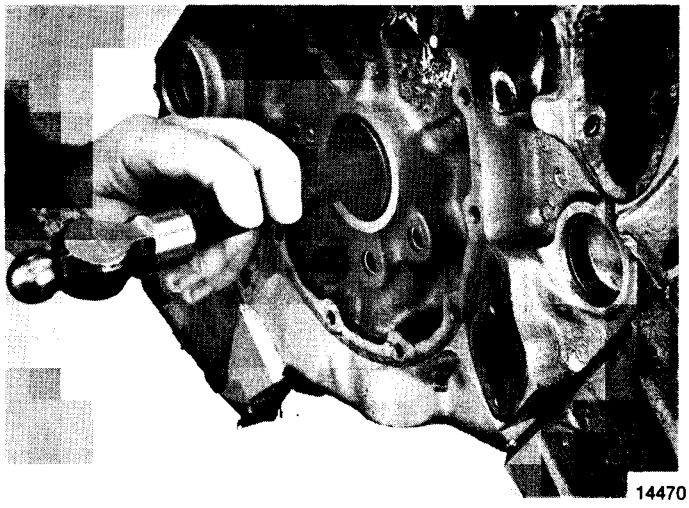
NOTE: This procedure is based on removal of bearings center of engine first, thus requiring a minimum amount of turns to remove all bearings.

2. Using tool set J-6098-01 (with nut and thrust washer installed to end of threads), position pilot in front camshaft bearing and install puller screw through pilot.
3. Install tool with shoulder toward bearing. Be sure a sufficient amount of threads are engaged.
4. Using 2 wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove tool and bearing from puller screw.
5. Remove remaining bearings (except front and rear) in same manner. It will be necessary to position pilot in rear camshaft bearing to remove rear intermediate bearing.



Replacing Camshaft Bearings

6. Assemble remover tool on drier handle and remove front and rear camshaft bearings by driving toward center of cylinder block.



Replacing Front and Rear Camshaft Bearings

Inspection

Clean camshaft bearing bores in cylinder block with solvent and blow out with compressed air. Be sure grooves and drilled oil passages are clean.

Installation

Front and rear bearings should be installed first to act as a guide to center pilot when installing center and intermediate bearings.

Lubricate outer surface of new camshaft bearings with engine oil to ease installation.

IMPORTANT: All camshaft bearings are not the same. Be sure to install bearing in proper location (indicated by bearing manufacturer) and to position bearings as follows: (Directional references are in reference to engine in its normal operating position.) Front, Intermediate and Center camshaft bearings must be installed so that oil hole in each aligns with oil hole in block. Rear bearing bore is grooved and bearing oil hole must be positioned at or near the 6 o'clock position.

1. **Installing Intermediate and Center Bearings:**
   a. Install nut and thrust washer all-the-way onto puller screw, then position pilot in front camshaft bearing bore and insert screw thru pilot.

b. Index center camshaft bearing, then position appropriate size remover and installer tool in bearing and thread puller screw into tool. Be sure at least 1/2" (13mm) of threads are engaged.

c. Using 2 wrenches, hold puller screw and turn nut until bearing has been pulled into position. Remove the remover and installer tool and check to ensure that oil hole(s) in bearing are positioned correctly.

d. Install intermediate bearings in same manner being sure to index bearings correctly. It will be necessary to position pilot in rear camshaft bearing bore to install rear intermediate bearing.

2. **Installing Front and Rear Bearings:**

a. Install appropriate size remover and installer tool on drive handle.

b. Index front bearing (as explained in "Important"), and drive it into position with tool. Check position of oil hole(s) in bearing to ensure bearing is positioned correctly.

c. Install rear bearing in same manner, being sure to index bearing correctly.

3. Install a new camshaft rear plug.

IMPORTANT: Plug must be installed flush to 1/32" (.8mm) deep and must be parallel with rear surface of cylinder block.

4. Install crankshaft and camshaft as outlined.

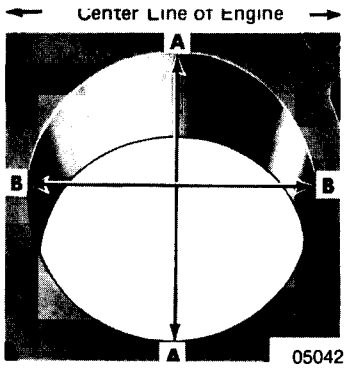
Cylinder Block

Cleaning and Inspection

1. Remove all engine components as previously outlined.
2. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
3. Remove oil gallery plugs and clean all oil passages.

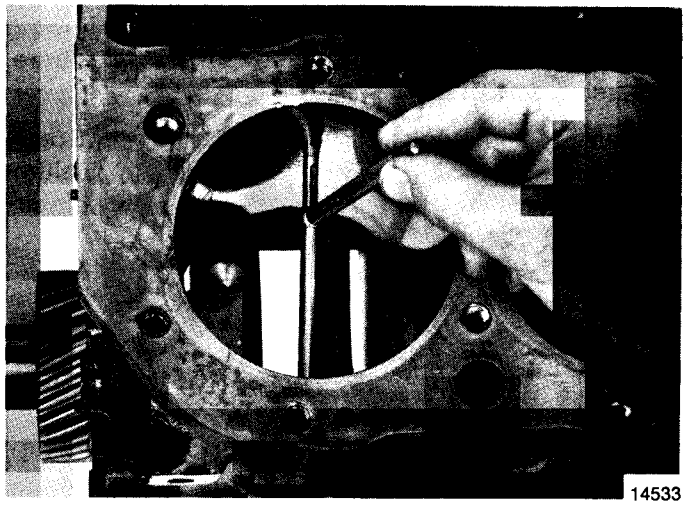
NOTE: These plugs may be removed with a sharp punch, or they may be drilled and pried out.

4. Clean and inspect water passages in cylinder block.
5. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.
6. Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring and/or honing will be necessary.

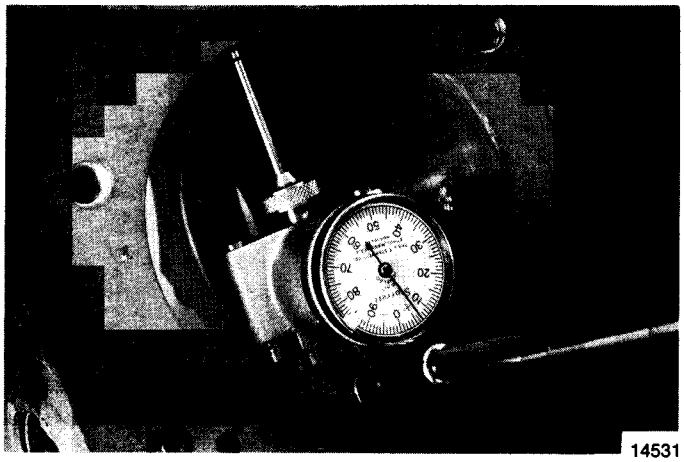


"A" = At right angle to centerline of engine
"B" = Parallel to centerline of engine
"Out-of-round" = Difference between "A" and "B"
"Taper" = Difference between measurement "A" at top of cylinder bore and "A" measurement at bottom of cylinder bore.

Cylinder Measurement

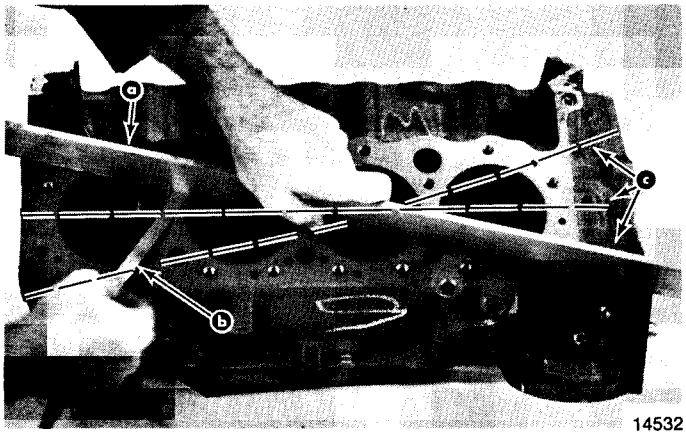


Measuring Cylinder Bore



Measuring Cylinder Bore

7. Check cylinder head gasket surfaces for warpage with a machinists straight edge and a feeler gauge, as shown. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are out-of-flat more than .003" (.07mm) in a 6" area or .007" (.2mm) overall, block must be resurfaced by an automotive machine shop.



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a - Machinists Straight Edge
b - Feeler Gauge
c - Take Measurements Diagonally Across Surface and Straight Down Center

Checking Cylinder Head Gasket Surfaces for Warpage

Repairs

CYLINDER CONDITIONING:

1. Performance of the following operation depends upon engine condition at time of repair.
2. If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.
3. If cylinders have less than .005" (.127mm) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of less than .005" wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to rebore for an oversize piston. If more than .005" taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
4. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER BORING

1. Before using any type boring bar, file off top of cylinder block to remove dirt or burrs. This is very important to prevent boring bar tilt, with result that rebored cylinder wall is not at right angles to crankshaft.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

NOTE: Hone cylinders as outlined under "Cylinder Honing" and "Piston Selection", following.

3. Carefully observe instructions furnished by manufacturer of equipment being used.

CYLINDER HONING:

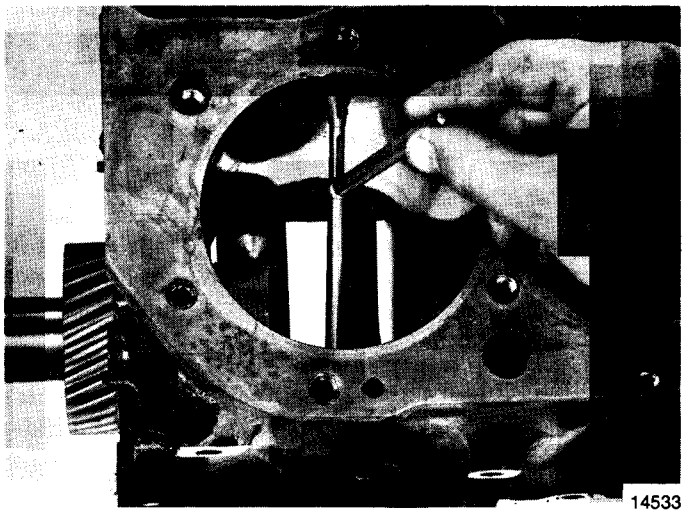
1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up-and-down at a sufficient speed to obtain very fine uniform surface finish marks in a cross-hatch pattern of approximately 30° to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as this type piston can be distorted by careless handling.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by the contaminated oil. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

PISTON SELECTION:

1. Check USED piston to cylinder bore clearance as follows:
   a. Measure "cylinder bore diameter" with a telescope gauge 2-1/2" (64mm) from top of cylinder bore.
   b. Measure "piston diameter" at skirt across center line of piston pin.
   c. Subtract piston diameter from cylinder bore diameter to determine "piston-to-bore clearance".
   d. Determine if "piston-to-bore clearance" is in acceptable range shown in "Specifications".
2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (preferable range).
4. Mark piston to identify cylinder for which it was fitted.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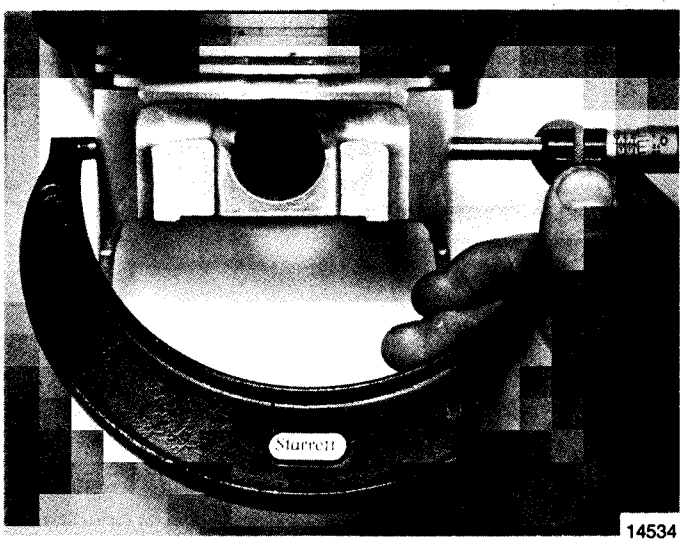
Measuring Cylinder Bore



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Measuring Piston

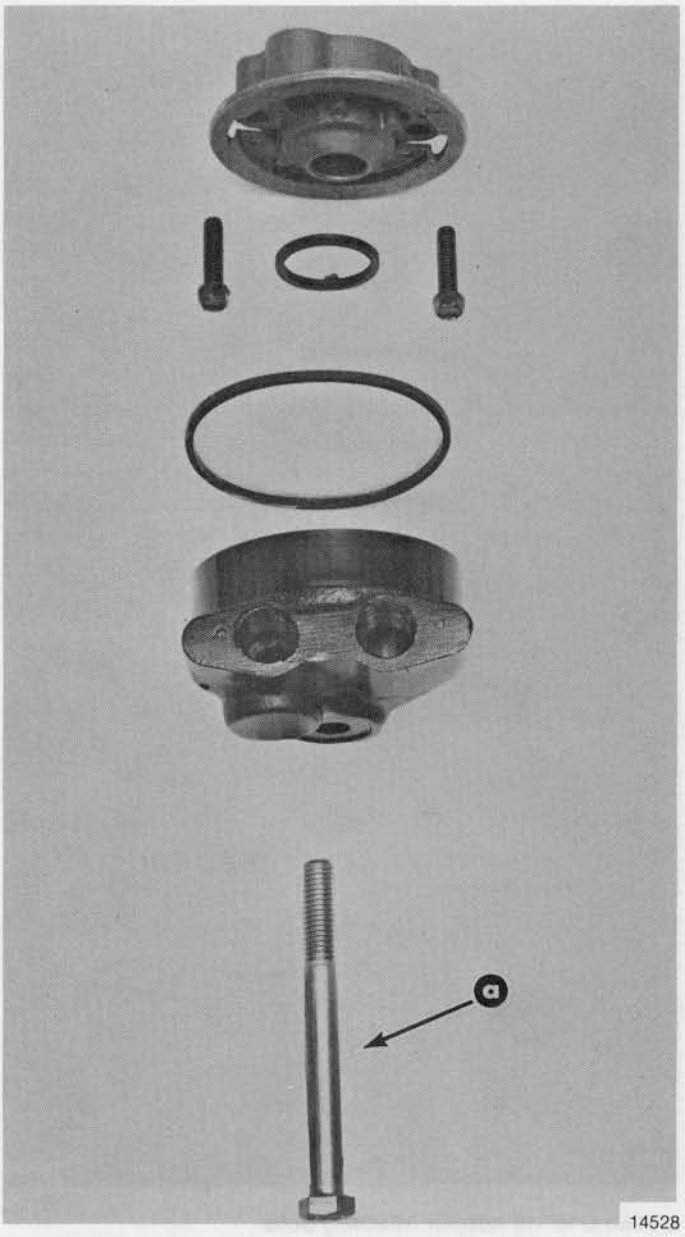
Replacement Part Information

If replacement of cylinder block is necessary, the following must be performed:

1. Retain double-ended main bearing cap attaching screws (used to support oil splash plate) for use with new engine. New engines are shipped with regular (single-ended) bolts only.
2. Retain oil filter by-pass valve and adaptor assembly and related parts for use with new engines.
3. If engine being replaced has a remote oil filter, check the cylinder block being replaced to determine method used to attach cylinder block adaptor to cylinder block. Refer to "Oil Filter By-Pass Valve and Adaptor Assembly". If it uses the older style adaptor that is secured to the block with one 1/2-13 bolt, a Remote Oil Filter Adaptor Kit (90783A9) is required to adapt the remote oil filter to new block. All new blocks are machined to accept new style oil hoses to cylinder block adaptor which is secured to block with two 5/16-18 screws.

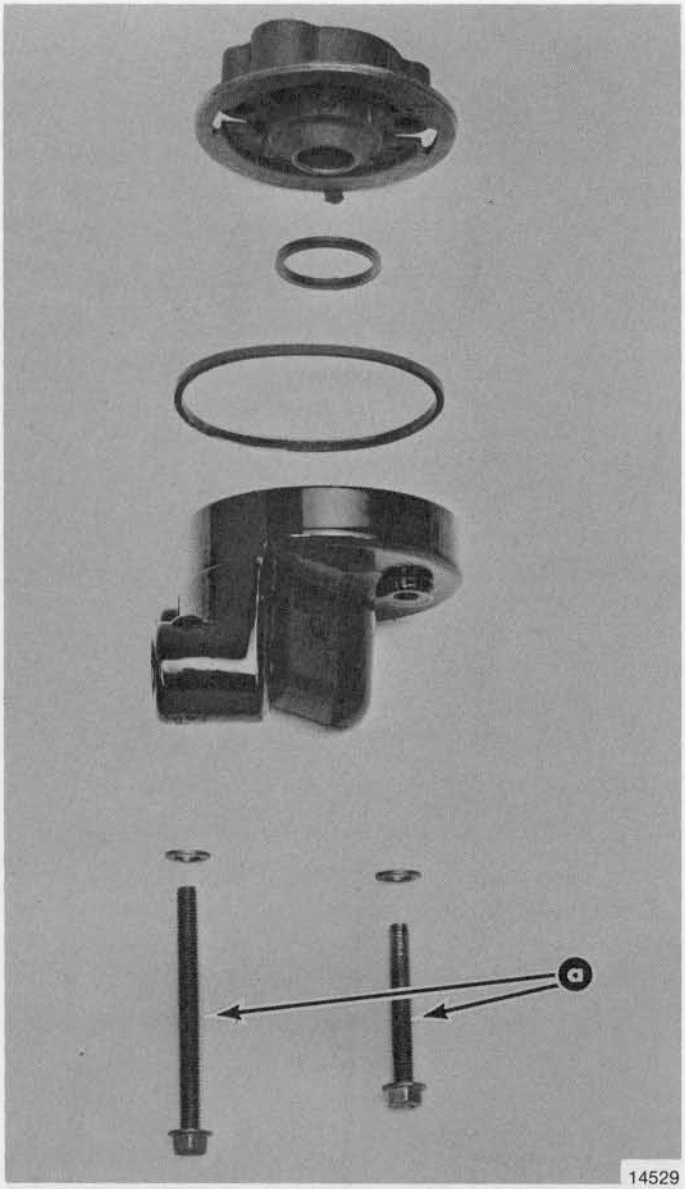
Oil Filter By-Pass Valve and Adaptor Assembly

Oil Filter By-Pass Valve and Adaptor Assembly for Engines With Block Mounted Oil Filter



a - One 1/2"-13 Adaptor Attaching Bolt

Engines With Remote Oil Filter Adaptor (1/2"-13 Bolt)



a - Two 5/16"-18 Adaptor Attaching Bolts

Engines With Remote Oil Filter Adaptor (5/16"-18 Bolts)

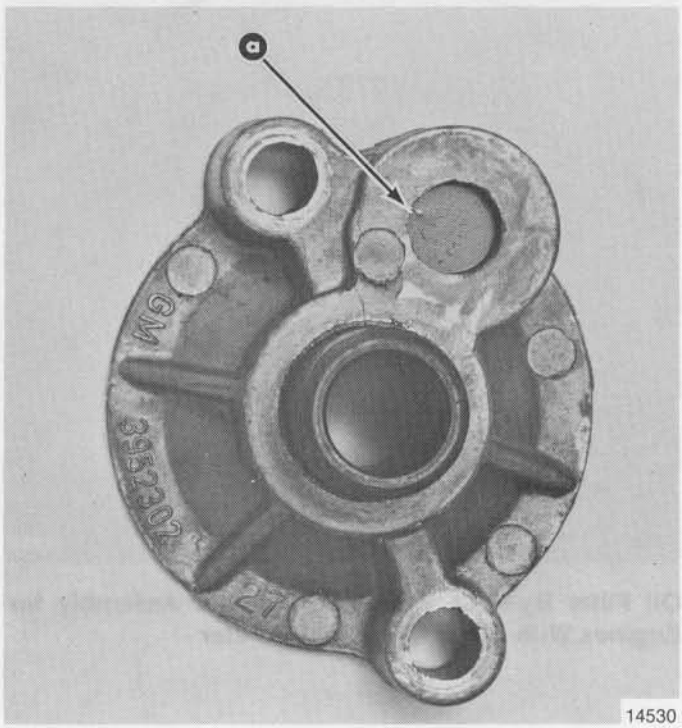
Inspection and/or Replacement

IMPORTANT: Production-performance engines do not use an oil filter by-pass valve. On these engines, by-pass valve is removed from adaptor and oil by-pass hole is welded shut. Do not install an adaptor with a by-pass valve incorporated as inadequate oil filteration will result.

Oil by-pass valve and adaptor assembly should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filteration is suspected.

Refer to "Engine Parts List" when ordering parts for oil filter by-pass valve, adaptor assembly or remote oil filter parts.

1. Remove oil filter (on engines with block mounted filter) or cylinder block adaptor (on engines with remote oil filter) and remove by-pass valve and adaptor assembly.
2. Clean by-pass valve and adaptor assembly in solvent and blow dry with compressed air.
3. Inspect fiber valve for cracks or other damage. Check that valve fits tightly against its seat. Push valve down and release it. Valve should return freely to its seat. If valve operation is questionable, by-pass valve and adaptor assembly should be replaced.



a - Fiber Valve (Be Sure Valve Fits Tightly Against Its Seat)

Typical By-Pass Valve and Adaptor Assembly

4. Wipe out valve chamber in cylinder block to remove any foreign material.
5. Install by-pass valve and adaptor assembly and oil filter or cylinder block adaptor and secure as shown. Be sure to torque bolts or screws to specifications.

Remote Oil Filter Kit (90783A9)

MerCruiser MCM 400/440/460, Stern Drive Engines

INSTALL KIT AS SHOWN:

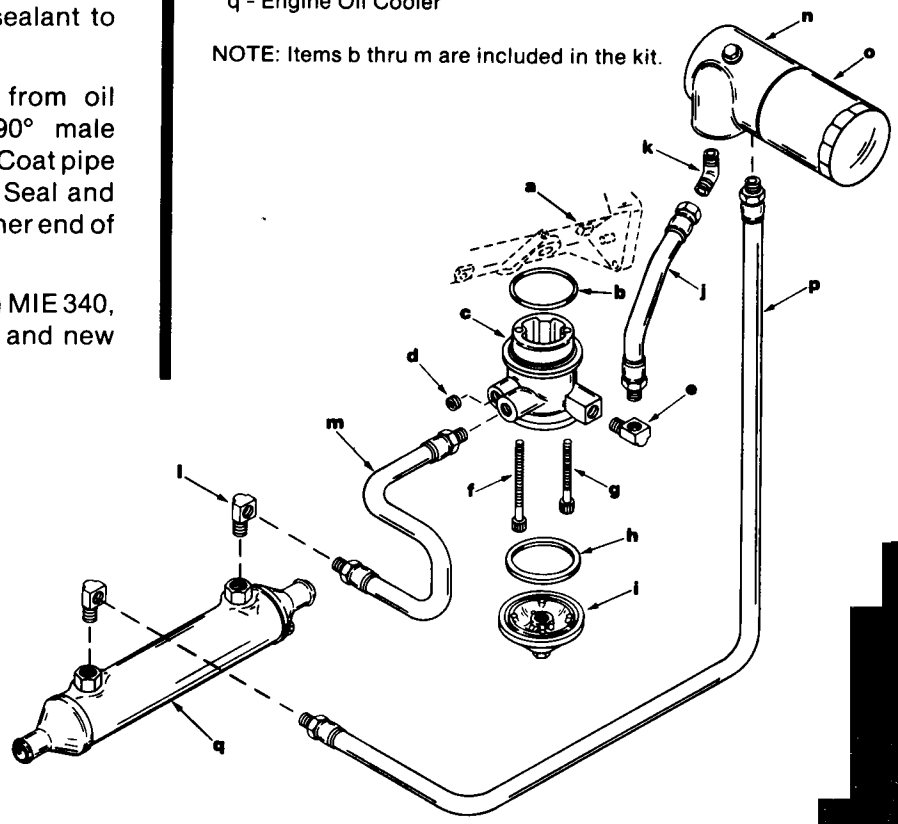
- Before installing pipe plug (d), 90° elbow (e) and 45° male connector (k), coat pipe threads with Quicksilver Perfect Seal. Tighten securely.
- Torque screws (f & g) to 20-25 lbs. ft. (27-34 N.m).
- When installing hose (j), coat pipe thread end with Perfect Seal. Do not apply any kind of sealant to swivel end. Tighten securely.
- Remove and retain original hose (m) from oil cooler. Remove and discard original 90° male elbow and replace with new 90° elbow (l). Coat pipe thread end of original hose with Perfect Seal and install into oil adaptor assembly. Install other end of hose without sealant into new 90° elbow.

NOTE: EXTRA PARTS. When installing kit on MIE 340, one 90° elbow, the straight male connector and new 30" (762mm) hose will not be needed.

Remote Oil Filter System (MIE, MCM)

a - Engine Cylinder Block
b - "O" Ring (25-35029)
c - Oil Adaptor Assembly (90783A8)
d - Pipe Plug (22-37372)
e - 90° Elbow (22-48246)
f - 5/16" - 18 x 4" (102mm) Screw (10-91966)
g - 5/16" - 18 x 3-1/4" (83mm) Screw (10-91967)
h - Gasket (27-91892)
i - Adaptor Cover (91830)
j - 24" (610mm) Hose (32-48242-49)
k - 45° Male Connector (22-71923)
l - 90° Male Connector (22-63825)
m - Hose, Original (Oil Cooler to Adaptor)
n - Oil Filter Adaptor (Original)
o - Oil Filter (Original)
p - Hose, Original (Oil Cooler to Oil Filter Adaptor)
q - Engine Oil Cooler

NOTE: Items b thru m are included in the kit.



Remote Oil Filter Kit (92043A2) Installation Instructions

IMPORTANT: Retain existing parts unless stated otherwise.

MERCRUISER STERN DRIVES 454 CID ENGINES WITH CENTER EXHAUST ELBOWS.

IMPORTANT: If installing kit on engine equipped with 2 studs (16-34713) must be ordered.

MODIFY PORT EXHAUST ELBOW

⚠CAUTION

Water must be drained from exhaust manifold to prevent water from entering combustion chamber when hose is removed.

1. If equipped with standard cooling system, remove hose clamp, hose and straight fitting from front of exhaust elbow. Discard fitting only. If equipped with Closed Cooling System, proceed with Step 2.
2. Coat threads of 45° fitting (from kit) with Quicksilver Perfect Seal.
3. Insert fitting in elbow opening and tighten securely. Position fitting to point toward engine. Replace hose and tighten hose clamp.
4. Remove front 2 exhaust elbow attaching nuts, washers and studs. Discard studs.

MODIFY OIL FILTER OPENING IN CYLINDER BLOCK

1. Remove and discard existing filter, 2 screws and filter valve.

INSTALL REMOTE OIL FILTER ASSEMBLY

1. Remove oil filter adaptor cover and mount adaptor body with 2 screws provided. Be sure cover seal and adaptor "O" ring are in place. Torque to 20-25 lbs. ft. (27-34 N.m).
2. Route hoses up and between exhaust manifold and engine.

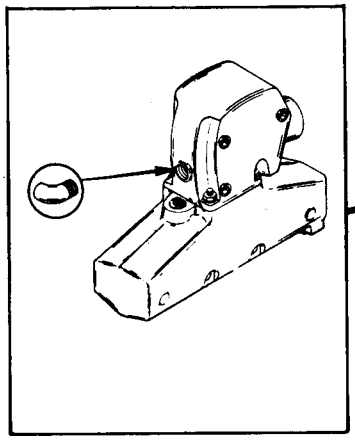
⚠CAUTION

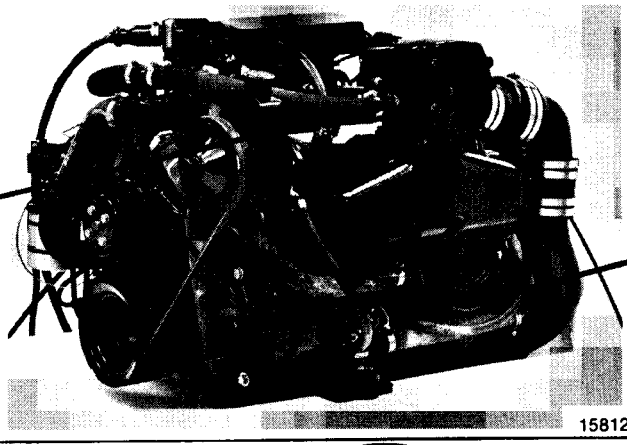
Hoses must not contact hot spots on exhaust manifold.

3. Install oil filter bracket on front of exhaust elbow. Where elbow is fastened to manifold or 6" (152mm) riser, use 2 screws (from kit) and original washers. Discard original nuts. Torque to 20-25 lbs. ft. (27-34 N.m).

NOTE: If installing kit on engine equipped with 3" (76mm) risers and replacement studs, use original washers and nuts. Discard 2 screws from kit.

4. Run engine until warm. Stop engine and wait 5 minutes. Check crankcase oil level and add oil if necessary.





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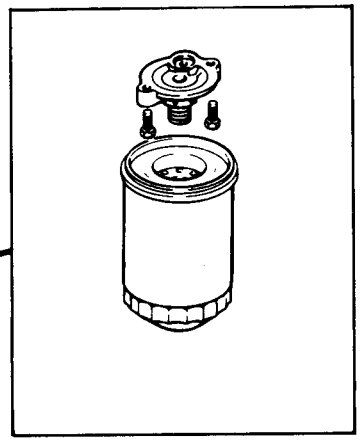
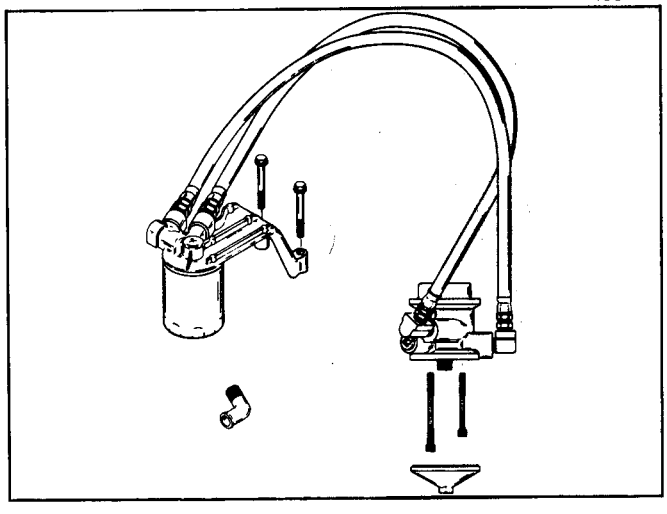
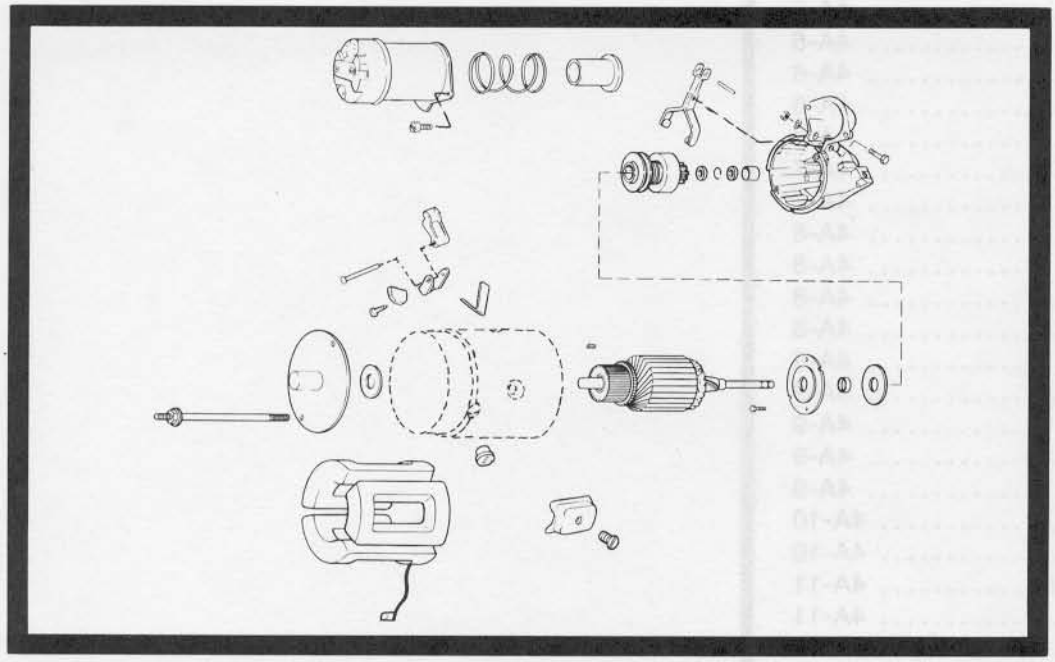




ELECTRICAL SYSTEM



4

A

STARTING SYSTEM

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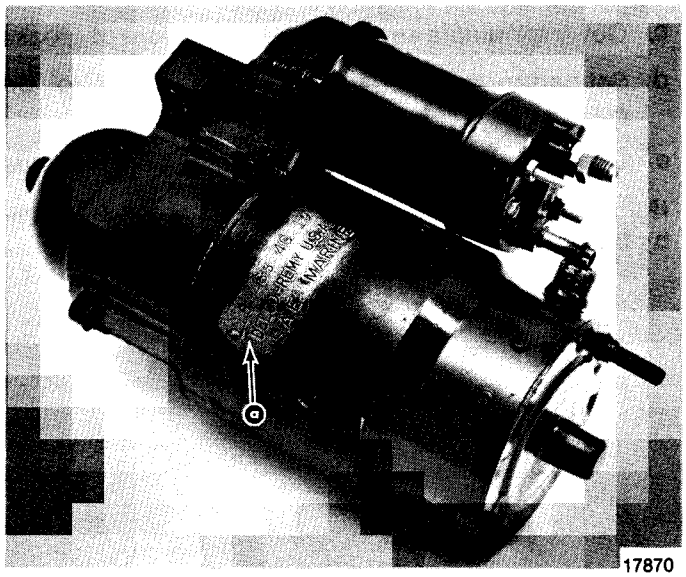
Identification

The starter identification number is located as shown.



⚠WARNING
Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Battery

IMPORTANT: Terminals must be soldered to cable ends to ensure good electrical contact. Use electrical grade (resin flux) solder only. Do not use acid flux solder, as it may cause corrosion and failure.

Battery Cable

Cable Length	Cable Gauge
Up to 3-1/2 Ft. (1.1m)	4 (19mm²)
3-1/2 - 6 Ft. (1.1-1.8m)	2 (32mm²)
6 - 7-1/2 Ft. (1.8-2.3m)	1 (40mm²)
7-1/2 - 9-1/2 Ft. (2.3-2.9m)	0 (50mm²)
9-1/2 - 12 Ft. (2.9-3.7m)	00 (62mm²)
12 - 15 Ft. (3.7-4.6m)	000 (81mm²)
15 - 19 Ft. (4.6-5.8m)	0000 (103mm²)
Both positive (+) and negative (-) cables	

Maintenance

⚠WARNING
Hydrogen gases that escape from the battery during charging are explosive. Be sure that battery area is well ventilated and that bilge blower is in operation when charging. Do not smoke or allow sources of spark or open flame in area when charging battery.

⚠WARNING
Battery electrolyte is a corrosive acid and should be handled with extreme care. If electrolyte is spilled or splashed on any part of the body, immediately flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible. Safety glasses and rubber gloves are recommended when handling batteries.

⚠CAUTION
To prevent damage to the electrical system be sure to adhere to the following:

a. **When installing battery, be sure to connect the (-) negative (grounded) battery cable to the (-) negative battery terminal and (+) positive battery cable to (+) positive battery terminal.**

b. **Never disconnect the battery cables while the engine is running.**

c. **If a charger or booster is to be used, be sure to connect it in parallel with existing battery (positive to positive and negative to negative).**

d. **When applying a booster charge to battery, disconnect both cables from battery (to prevent damage to voltage regulator).**

e. **Check battery condition periodically.**

f. **Make sure that battery leads are kept clean and tight.**

Testing

Place battery under heavy load (as during engine cranking or with a variable resistor tester) and test cell voltage while under load.

Certain conditions must be met before testing.

a. Battery must be between 60° and 100°.

b. Electrolyte level must be correct in all cells.

c. Battery must be at least half charged.

d. No obvious defects.

1. Check voltage per manufacturers specifications.
2. If readings are low, recharge and retest.
3. If readings remain low, battery should be replaced.

⚠CAUTION

Test battery in well ventilated area as gases given off by battery are hazardous.

Storage

a. Remove battery and clean exterior.

b. Check fluid level and fill if low.

c. Cover terminals and bolts with light coat of grease.

d. Set battery on wood or in carton, store in cool, dry place.

e. Check every 20 days for fluid level and slow charge.

IMPORTANT: A discharged battery can be damaged by freezing.

Specifications

DELCO IDENTIFICATION NUMBER	ENGINE ROTATION	NO LOAD TEST					BRUSH SPRING TENSION OZ. (GRAMS)
		VOLTS	MIN. AMPS	MAX. AMPS	MIN. RPM	MAX. RPM	
1998314	L.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1998315	R.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1998316	L.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1998317	L.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
1998318	L.H.	10.6	60	100	5300	10,600	56-105 (1588-2976)
1998404	L.H.	10.6	60	100	5300	10,600	56-105 (1588-2976)
1998460	L.H.	10.6	60	100	5300	10,600	56-105 (1588-2976)
1998405	R.H.	10.6	60	100	5300	10,600	56-105 (1588-2976)
1998513	L.H.	10.6	60	100	5300	10,600	56-105 (1588-2976)
1998568	L.H.	10.6	60	100	5300	10,600	56-105 (1588-2976)
1998566	L.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
PINION CLEARANCE					.010 - .140 (.25 - 3.5mm)		
COMMUTATOR END FRAME GAP					.025 MAX. (.6mm MAX.)		

L.H. = LEFT HAND ENGINE ROTATION
R.H. = RIGHT HAND ENGINE ROTATION

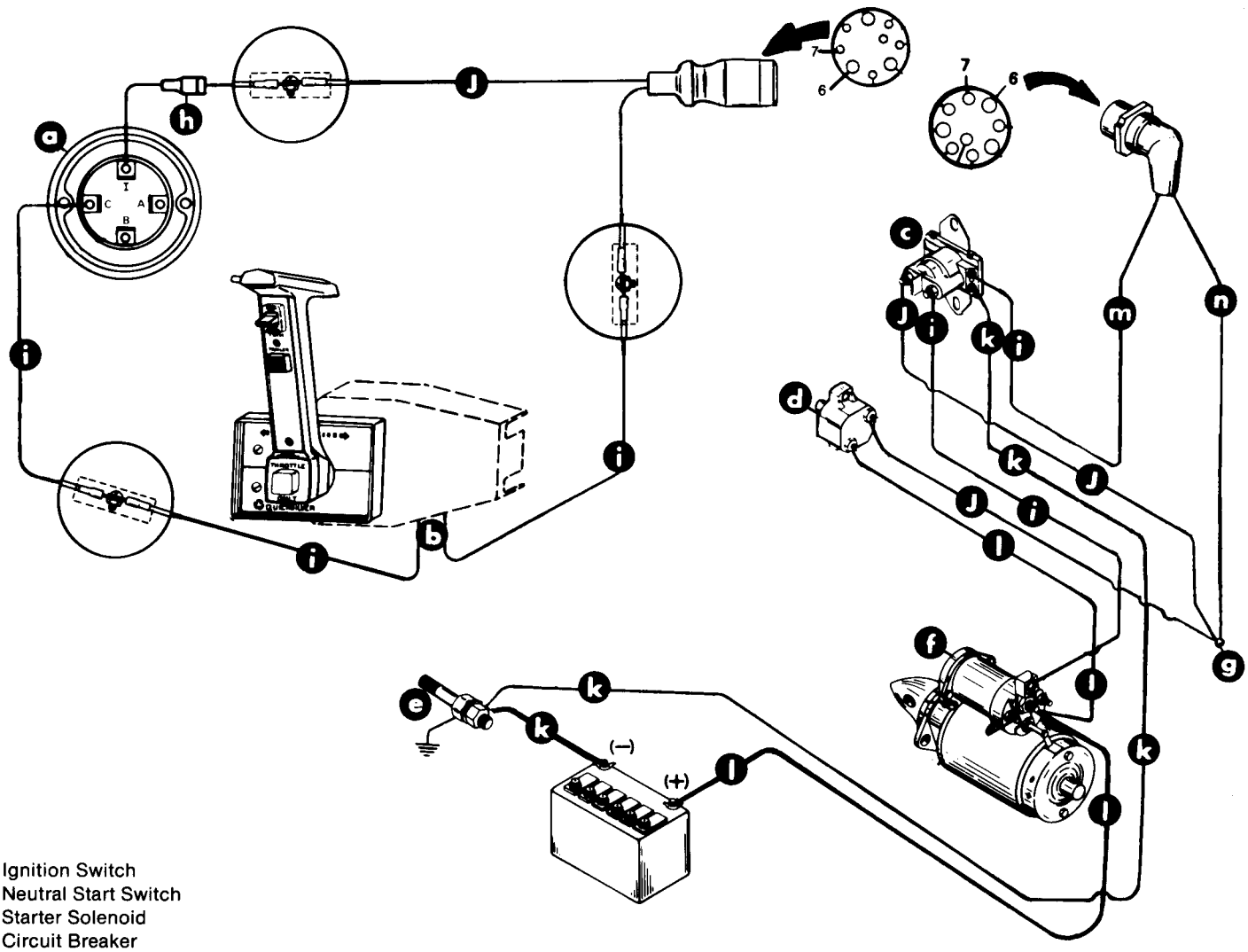
TORQUE SPECIFICATIONS

FASTENER LOCATION	LBS. FT. (N.m)	LBS. IN. (N.m)
Starter Motor to Block	50 (68)	

LUBRICANTS - SEALANTS

92-25711 Liquid Neoprene
SAE 10W Oil
SAE 20W Oil

Starting System Components



a - Ignition Switch
b - Neutral Start Switch
c - Starter Solenoid
d - Circuit Breaker
e - Engine Ground Stud
f - Solenoid Switch
g - Wire Junction
h - 20 Amp Fuse
i - Yellow-Red
j - Red-Purple
k - Black
l - Red
m - Yellow-Red 7
n - Red-Purple 6

Diagnosis

This is a general description of the positive current flow, from the battery and thru the system until the starter motor cranks.

A Battery to the solenoid switch (on starter) (RED battery cable)

B Solenoid switch to circuit breaker (RED)

C Circuit breaker to wire junction (RED-PUR)

D Wire junction to wiring harness plug (RED-PUR) Terminal #6

E Wiring harness plug to 20 AMP fuse (RED-PUR)

F 20 AMP fuse to ignition switch Terminal "I" (RED-PUR) At this point ignition switch is turned to "Start"

G Ignition switch Terminal "I" to Terminal "C"

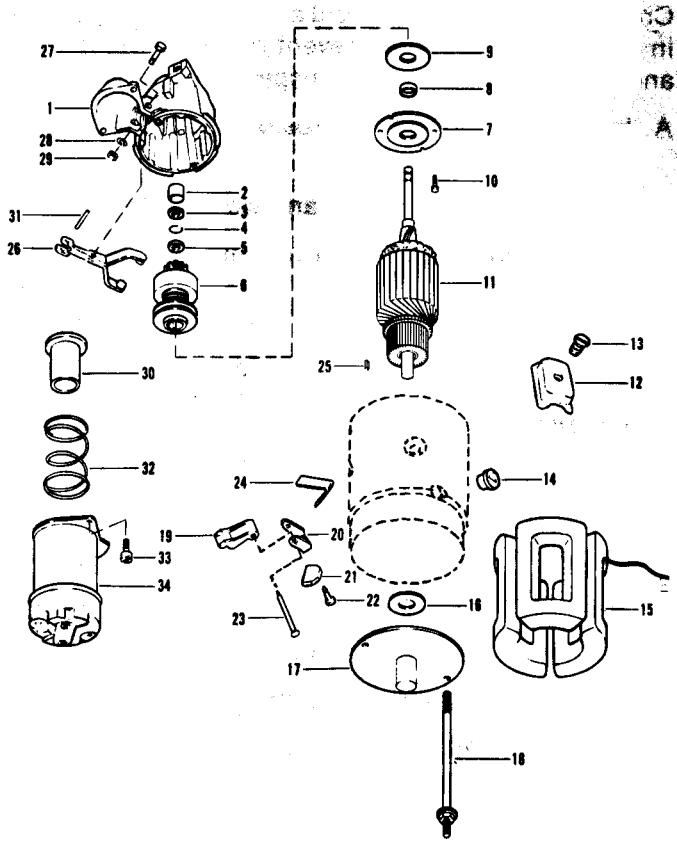
H Ignition switch Terminal "C" to neutral start switch (YEL-RED) neutral start switch must be at neutral position

I Neutral start switch to wiring harness plug terminal number "7" (YEL-RED)

J Wiring harness plug to starter solenoid (small terminal) (YEL-RED). Also ensure that black (small terminal) wire is grounded.

K Starter Solenoid is now "closed" completing circuit between large terminal (RED-PUR) and other large terminal (YEL-RED) causing starter motor to crank.

Starter Motor Assembly



1 HOUSING, drive end
2 BUSHING, drive end housing
3 COLLAR, thrust
4 RING, retaining - pinion stop collar
5 COLLAR, pinion stop
6 DRIVE ASSEMBLY, clutch
7 PLATE, bearing
8 BUSHING, bearing plate
9 WASHER, bearing plate
10 SCREW, bearing plate
11 ARMATURE
12 SHOE, pole - field coil
13 SCREW, pole shoe to field coil
14 GROMMET, field coil - field frame
15 FIELD COIL ASSEMBLY
16 WASHER, leather - commutator end frame
17 FRAME, commutator end - lower
18 BOLT, thru
19 HOLDER, insulated - field frame brush
20 HOLDER, field frame brush ground
21 BRUSH, field frame
22 SCREW, brush lead
23 SUPPORT PACKAGE, ground and insulated holders
24 SPRING, field frame brush
25 PIN, dowel - field frame
26 LEVER, shift
27 STUD, shift lever
28 WASHER, shift lever stud
29 NUT, shift lever stud
30 PLUNGER, shift lever
31 PIN, plunger to shift lever
32 SPRING, plunger return
33 SCREW, solenoid switch
34 SOLENOID SWITCH ASSEMBLY

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required:

A Inspect terminals for corrosion and loose connections.

B Inspect wiring for frayed and worn insulation.

C Check mounting bolts for tightness.

Repair

Removal

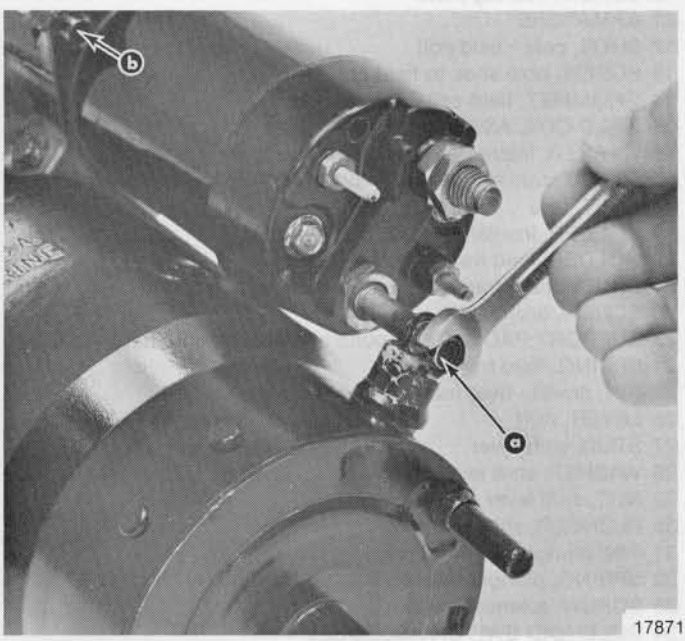
⚠WARNING
Disconnect battery cables at battery before removing starter.

1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.
3. Remove starter mounting bolts.
4. Pull starter assembly away from flywheel and remove from engine.

Solenoid Switch

REMOVAL

1. Remove starter motor as outlined.
2. Remove screw from field coil connector and solenoid attaching screws.
3. Twist solenoid to disengage tab, and remove.



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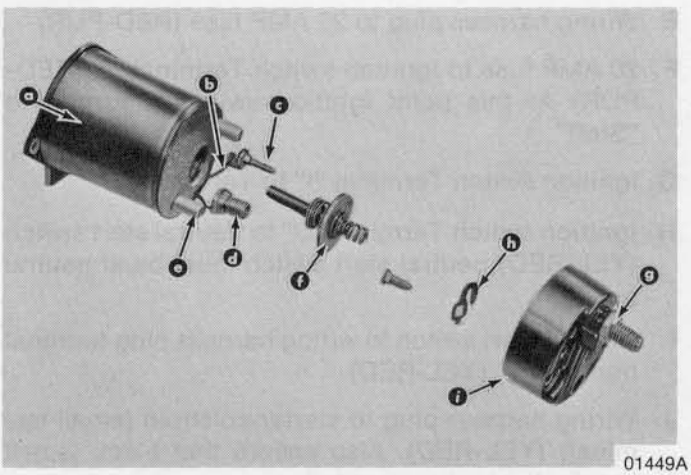
a - Field Coil Screw
b - Attaching Screws

REPLACEMENT of CONTACTS

1. With solenoid removed from motor, remove nuts and washers from switch ("S") terminal and starter motor connector strap terminal.
2. Remove solenoid end cover retaining screws and washers and remove end cover from solenoid body.
3. Remove nut and washer from battery terminal on end cover and remove battery terminal.

IMPORTANT: Do not cut starter motor connector strap terminal wire to remove terminal, or wire will be too short.



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a - Solenoid Body
b - To Hold in Coil
c - Switch Terminal
d - Motor Connector Strap Terminal
e - To Pull in Coil
f - Contact Ring and Push Rod Assembly
g - Battery Terminal
h - Contact Finger
i - End Cover

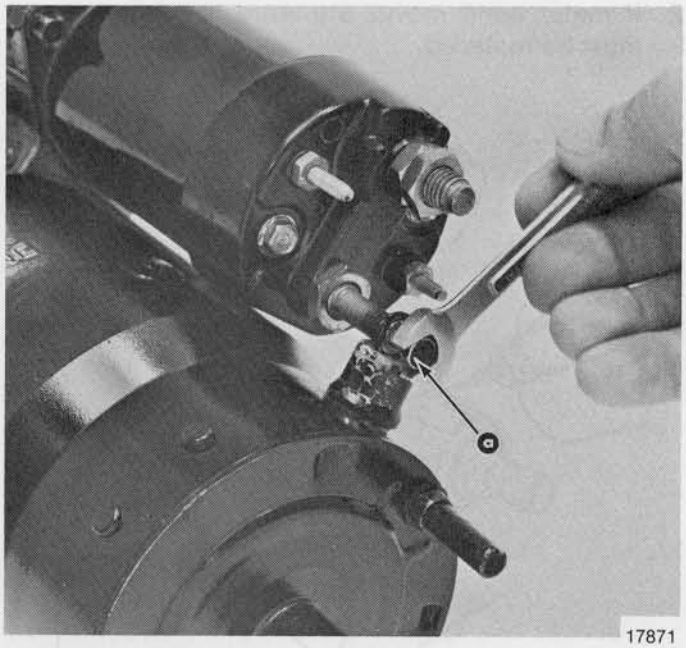
4. Remove motor connector strap terminal and solder new terminal in position.
5. Remove and install new battery terminal, washer and retaining nut to end cover.
6. Place new contact ring and push rod assembly in solenoid housing.
7. Position end cover over switch and motor terminals and install end cover retaining screws. Also install washers and nuts on solenoid switch and starting motor terminals.

INSTALLATION

1. Install solenoid onto plunger.
2. Twist solenoid to engage lock tab.
3. Install screws and tighten securely.
4. Install field coil connector screw.

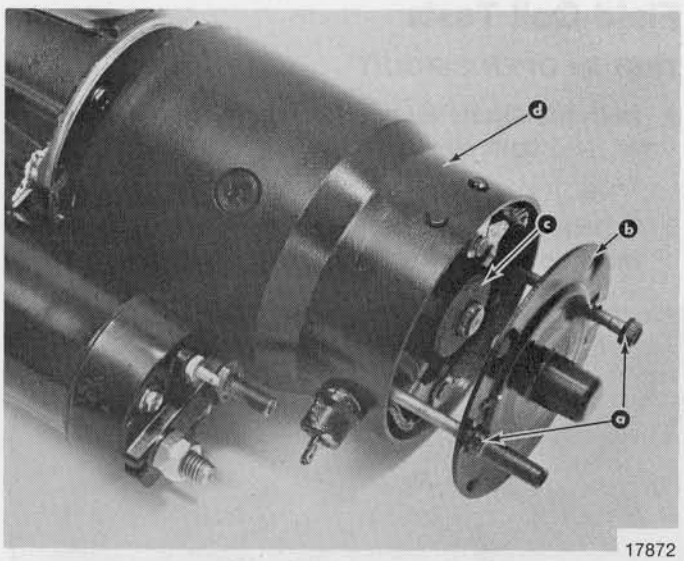
Starter Motor Disassembly

1. Remove screw from field coil connector.



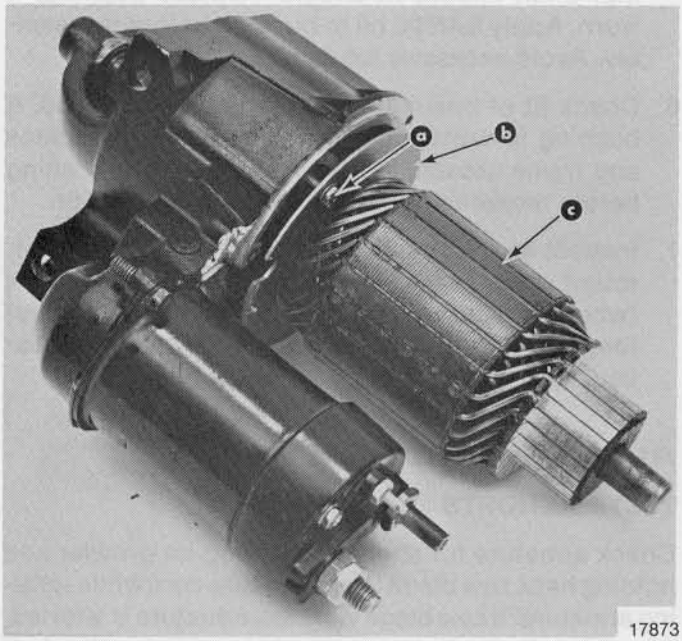
a - Connector Screw

2. Remove end frame thru bolts, end frame, washer and field frame.



a - Thru Bolts
b - End Frame
c - Washer
d - Field Frame

3. Remove screws, center bearing plate and armature.



a - Screws
b - Bearing Plate
c - Armature

4. Slide thrust collar off armature shaft.
5. Drive retainer ring toward armature.
6. Remove snap ring, retainer and clutch assembly.

Cleaning and Inspection

With starting motor completely disassembled, except for removal of field coils, component parts should be cleaned and inspected. Field coils should be removed only where defects are indicated by tests. Defective parts should be replaced or repaired.

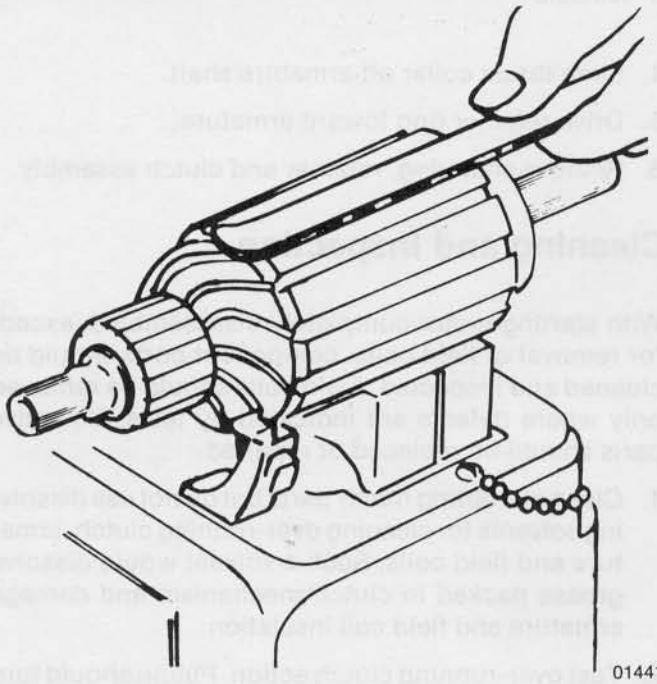
1. Clean all starting motor parts but do not use dissolving solvents for cleaning over-running clutch, armature and field coils. Such a solvent would dissolve grease packed in clutch mechanism and damage armature and field coil insulation.
2. Test over-running clutch action. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check pinion teeth. Check spring for tension and drive collar for wear. Replace if necessary.
3. Check that brush holders are not damaged or bent and will hold brushes against commutator.
4. Check brushes. Replace if pitted or worn to one-half their original length [5/16" (8mm) or less].

5. Check fit of armature shaft in bushing of drive housing. Shaft should fit snugle. Replace bushing, if worn. Apply SAE 20 oil to bushing before reassembly. Avoid excessive lubrication.
6. Check fit of bushing in commutator end frame. If bushing is damaged or worn excessively, replace end frame assembly. Apply SAE 20 oil to bushing before reassembly. Avoid excessive lubrication.
7. Inspect armature commutator. If rough or out-of-round, turn down and undercut. Inspect points (where armature conductors join commutator bars) for good, firm connection. Burned commutator bar usually is evidence of poor connection.

Armature Tests

TEST for SHORTS

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.



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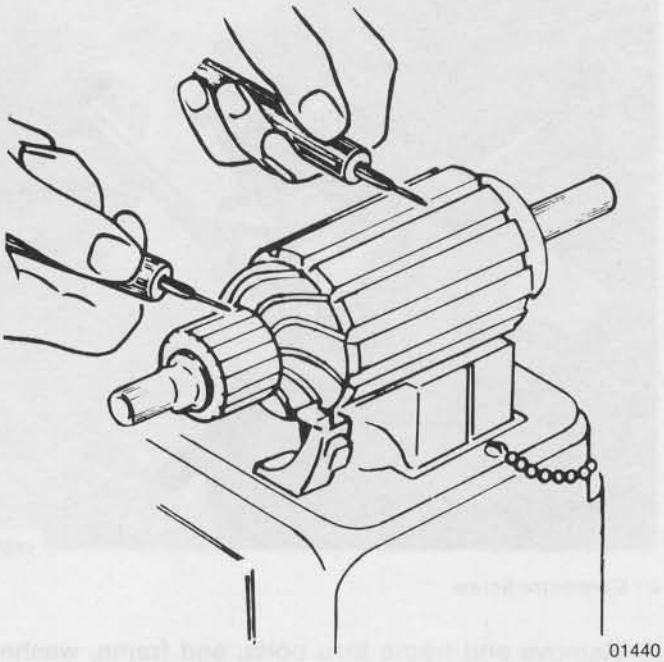
TEST for GROUND

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.
2. If meter hand moves armature is grounded and must be replaced.



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Field Coil Tests

TEST for OPEN CIRCUIT

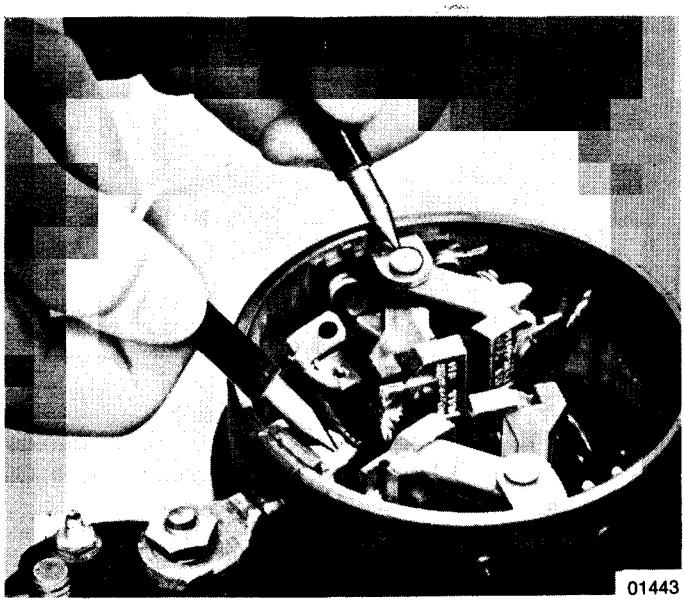
1. With continuity meter, place one lead on each end of field coils (insulated brush and field connector bar).
2. If meter does not move, field coils are open and must be replaced.

01442

TEST for GROUND

IMPORTANT: Be sure that positive brushes and leads do not contact field frame assembly during test, or false reading will result.

1. With continuity meter, place one lead on field connector bar and other lead on grounded brush.
2. If meter moves, field coils are grounded and must be replaced.



Loose Electrical Connections

If open soldered connection of armature to commutator leads is found during inspection, resolder with rosin flux.

IMPORTANT: NEVER USE ACID FLUX ON ELECTRICAL CONNECTIONS.

Turning the Commutator

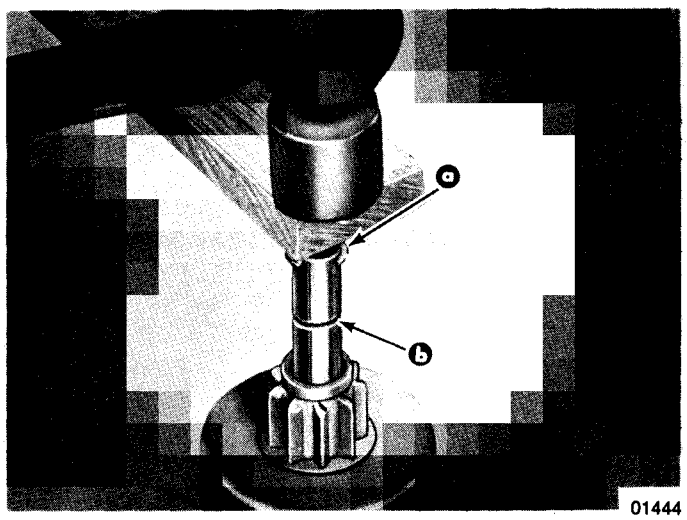
When inspection shows commutator roughness, clean as follows:

1. Turn down commutator in a lathe until thoroughly cleaned.
2. Recheck armature for shorts as outlined.

Reassembly

After all parts are thoroughly tested and inspected and worn or damaged parts replaced, reassemble starter as follows:

1. Assemble brushes and related parts to field frame as follows:
   a. Assemble brushes to brush holders. Attach ground wire to grounded brush and field lead wire to insulated brush.
   b. Assemble insulated and grounded brush holders together with "V" spring. Position as a unit and install support pin. Push holders and spring to bottom of support and rotate spring to engage center of "V" spring in slot in support.
2. Assemble over-running clutch assembly to armature shaft as follows:
   a. Lubricate drive end of armature shaft with SAE 10 oil.
   b. Slide assist spring and clutch assembly onto armature shaft with pinion outward.
   c. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).
   d. Drive snap ring onto shaft slide down into goove.
   e. Assemble thrust collar on shaft with shoulder next to snap ring.
   f. Place thrust collar nd retainer next to snap ring and using 2 pliers squeeze both until snap ring is forced into retainer.



a - Snap Ring
b - Groove

3. Place 4 or 5 drops of light engine oil in drive housing bushing. Slide armature and cluth assembly into place while engaging shift lever with clutch.
4. Position field frame over armature and apply Liquid Neoprene between frame against drive housing, observing caution to prevent damage to brushes.

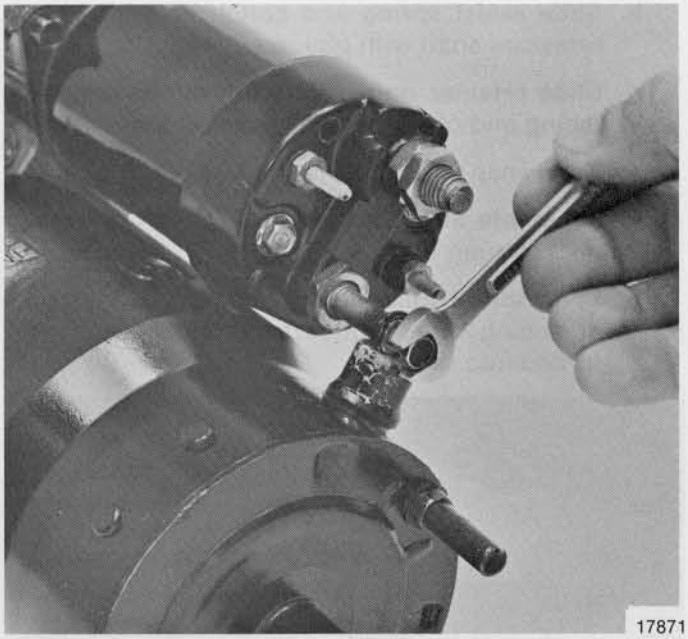
5. Place 4 to 5 drops of light engine oil in bushing in commutator end frame. Place brake washer and commutator end frame onto shaft.
6. Install solenoid return spring on plunger.
7. Position solenoid assembly to starter motor end frame and turn solenoid to engage flange in slot.
8. Install (and tighten securely) screws which hold solenoid assembly to end frame.
9. Secure starter motor connector strap terminal with screw and washer.

Clearances

PINION CLEARANCE

Pinion clearance must be checked as follows after reassembly of motor to insure proper adjustment.

1. Disconnect motor field coil connector from solenoid motor terminal and insulate it carefully.



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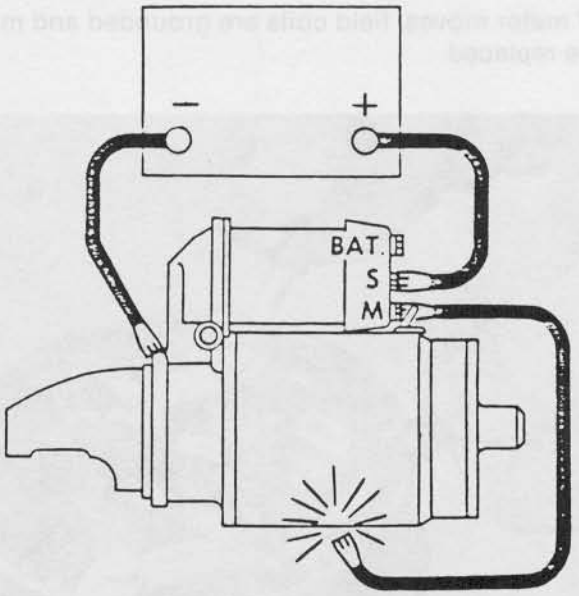
2. Connect 12-volt battery from solenoid switch(s) terminal to solenoid frame.
3. Momentarily touch a jumper lead from solenoid motor terminal to starter motor frame. This shifts pinion into cranking position where it will remain until battery is disconnected.



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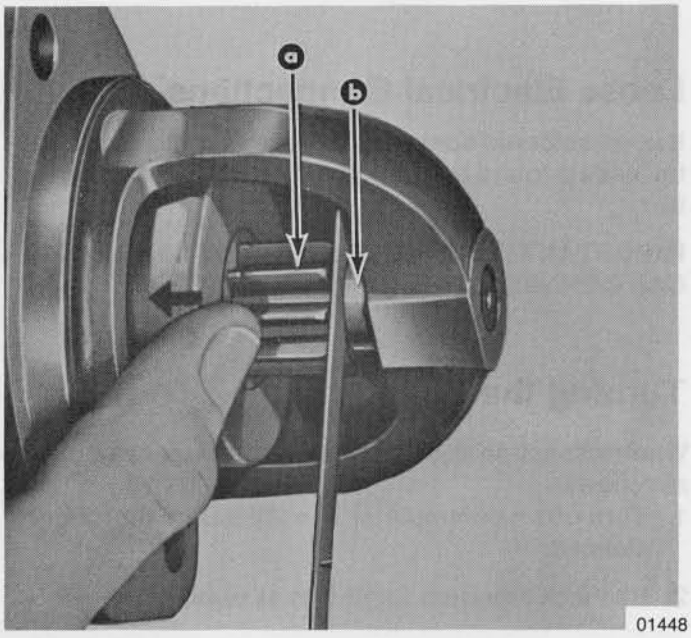
4. Push pinion back toward commutator end to eliminate slack.



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a - Pinion
b - Retainer

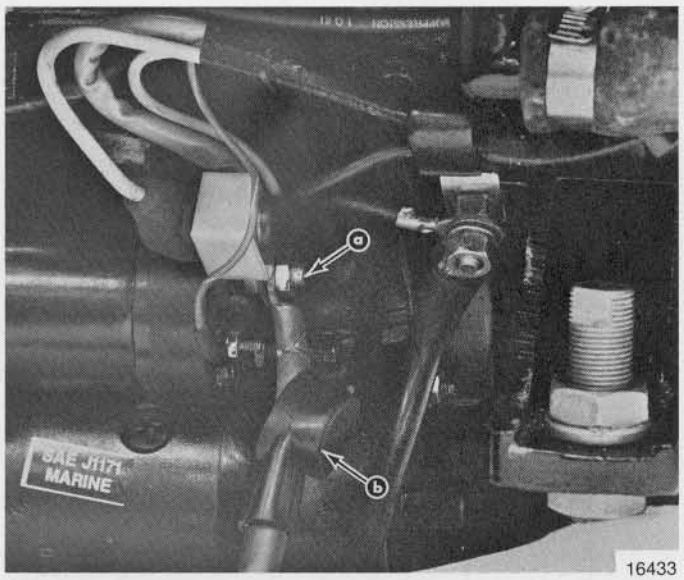
5. Measure distance between pinion and pinion retainer.
6. If clearance is not within specified limits, it may indicate excessive wear of solenoid linkage shift lever yoke buttons or improper assembly of shift lever mechanism. Check for proper assembly, and recheck gap. If still excessive, replace worn or defective parts, since no provision is made for adjusting pinion clearance.

COMMUTATOR END FRAME GAP

To keep the ignition-proof and safety requirement, the gap between the commutator end frame and field coil housing must be checked. See specifications. If the gap exceeds measurement when checked with a feeler gauge, the end frame should be checked for proper seating on the field coil housing. If properly seated and still found to have excessive gap, the end frame must be replaced.

Installation

1. Place starter motor and solenoid assembly in position and install mounting bolts.
2. Fasten wires as outlined in wiring diagram.
3. Coat solenoid terminal connections with Liquid Neoprene.
4. Place rubber boot over positive battery cable connection.

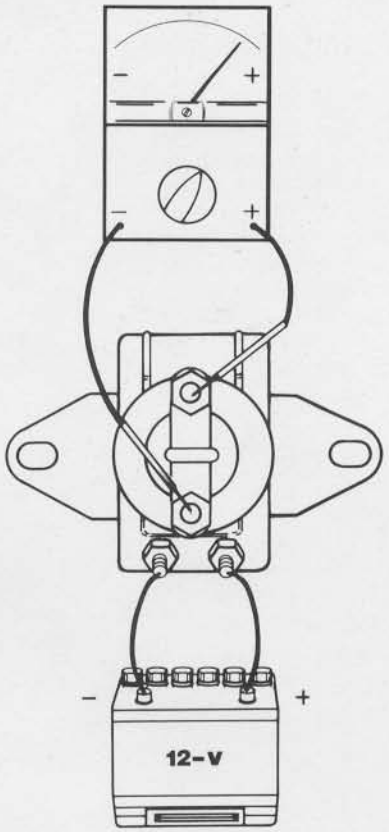


a - Positive Battery Cable Connection
b - Rubber Boot

Standard Starter Type Solenoid

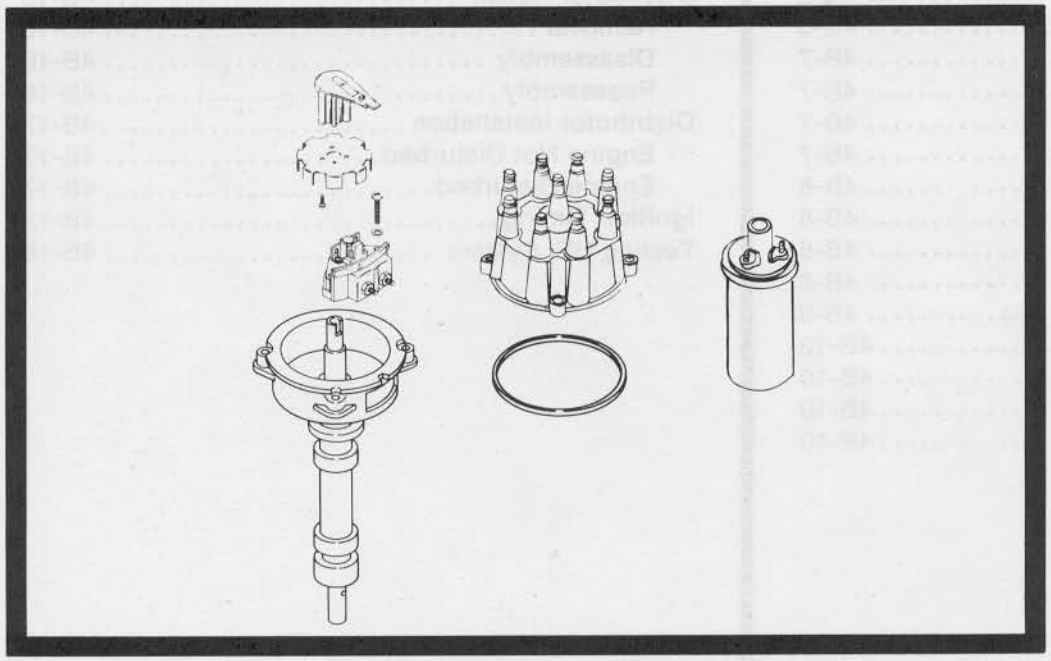
Testing/Replacement

1. Using continuity meter, connect test leads as shown, and connect 12-volt battery with jumper leads as shown.



2. If no meter movement is present, replace solenoid.

ELECTRICAL SYSTEM



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B

IGNITION SYSTEM

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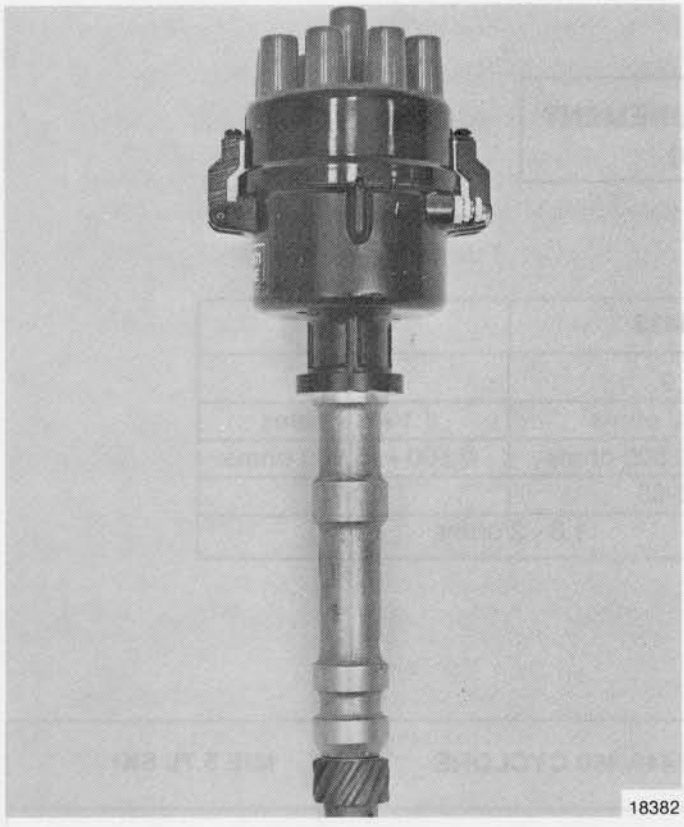
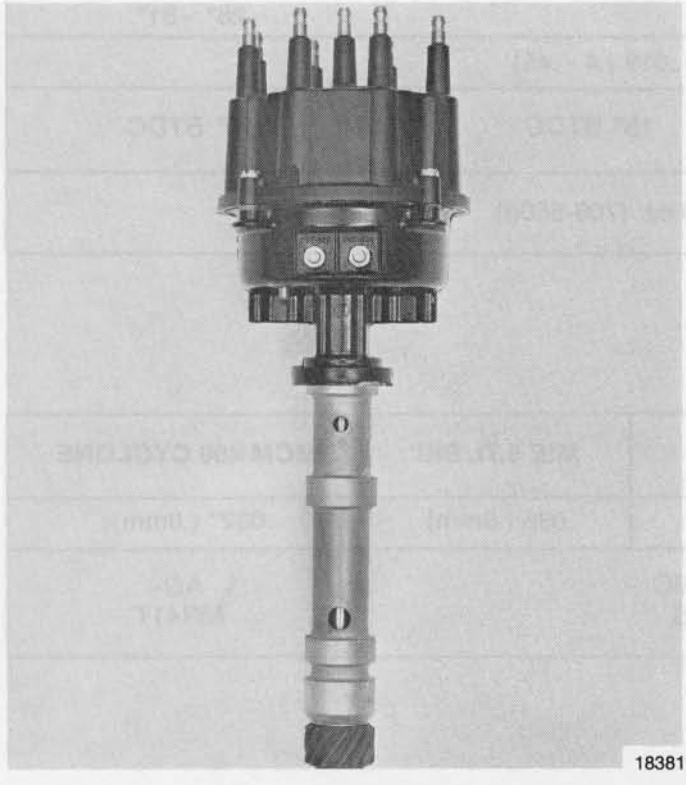


Mallory Distributor



Mercury Marine Thunderbolt IV (HEI) Distributor

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Mallory Distributor System

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)
Distributor Clamp 3/8-16	20 (27)
Spark Plugs (14mm)	15 (20)

Tools/Lubricants/Sealants

TOOLS	
91-59339	Dwell Meter
91-76032	Magneto Analyzer
91-52024A1	Remote Starter Switch
91-99379	Timing Light
91-99750	Volt/Ohm Meter

TOOLS OBTAINED LOCALLY
Spring Tension Gauge

SEALANTS	
92-25711	Quicksilver Liquid Neoprene

LUBRICANT OBTAINED LOCALLY
Distributor Cam Lubricant

Specifications

UNIT OF MEASUREMENT in. (mm)

Coil

Coil Part No.	26433	32193
Max. Operating Amps *	.9	1.1
Primary Resistance *	.9 - 1.2 ohms	1.1 - 1.5 ohms
Secondary Resistance *	7,500 - 10,500 ohms	9,500 - 15,000 ohms
Secondary Continuity *	53-63	60-70
Resistor Wire *	1.8 - 2 ohms	

NOTE: *Use Magneto Analyzer

Distributor

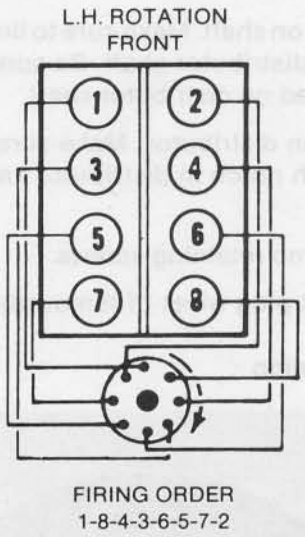
MODEL	MCM 370/400/400 CYCLONE	MCM 440/460 CYCLONE	MIE 5.7L SKI
Condenser*	.26 - .30 MFD.		
Point Dwell	26° - 31°		28° - 31°
Point Gap	.016 - .019 (.4 - .45)		
Timing	10° BTDC	15° BTDC	10° BTDC
Point Spring Tension	25 - 30 oz. (709-850g)		

NOTE: *Use Magneto Analyzer

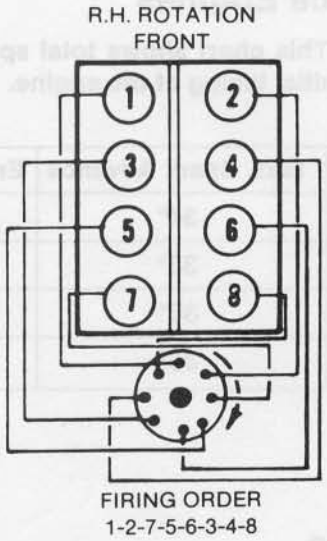
Spark Plugs

MODEL	MCM 370/400	400/440 CYCLONE	MIE 5.7L SKI	MCM 460 CYCLONE
Plug Gap	.035" (.9mm)	.032" (.8mm)	.035 (.9mm)	.032" (.8mm)
Plug Type	AC - MR43T/Champion RV8C Autolite - 144/NGK-BR6FS			AC- MR41T

Firing Order



L.H. (Standard) Rotation



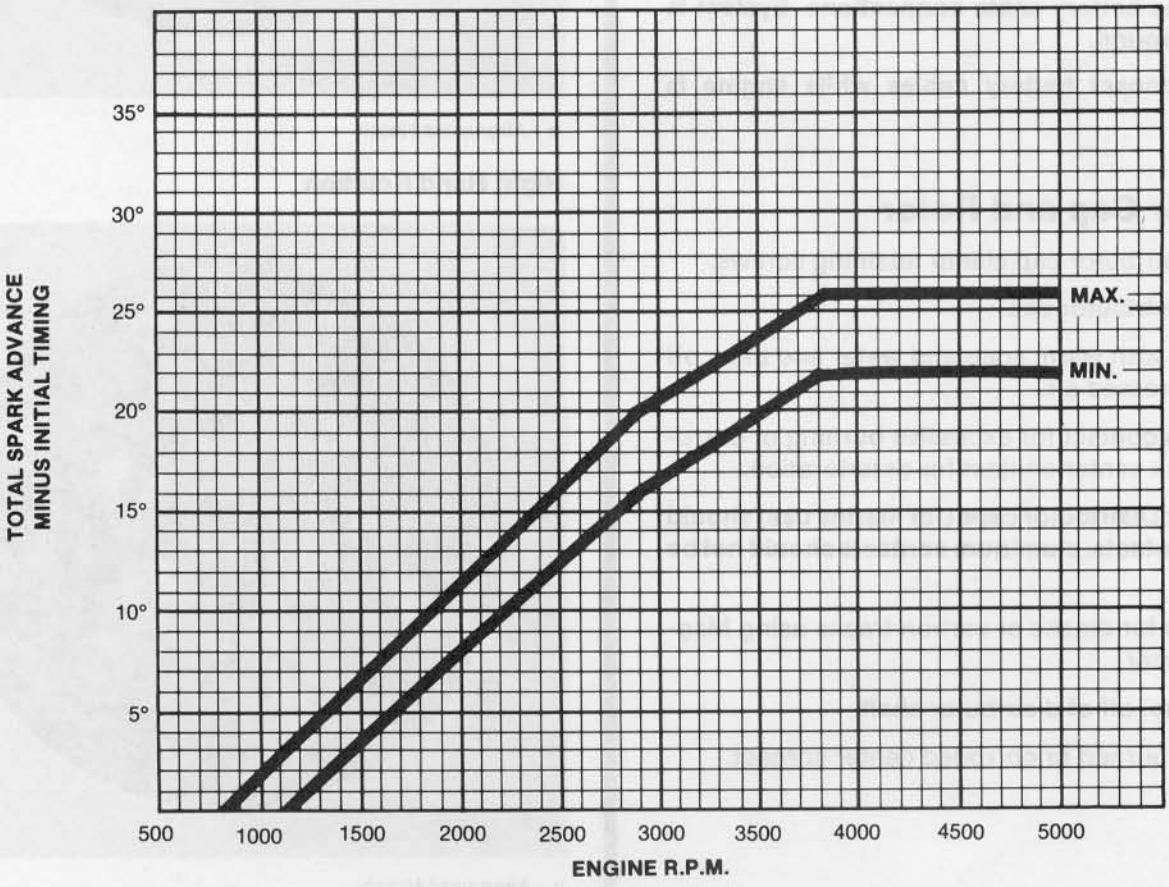
R.H. (Opposite) Rotation

Distributor Advance Curve

IMPORTANT: Distributor advance curve charts do not include the initial engine timing. Initial engine timing must be added to chart for total advance curve.

Example: A 5.7L Ski on the following chart reads 20° spark advance at 2900 RPM. Add 8° BTDC initial timing for a 5.7L and total spark advance would be 28° at 2400 RPM.

MIE 5.7L SKI



Total Spark Advance for Production Performance Engines

IMPORTANT: This chart shows total spark advance including the initial timing of the engine.

Model	Max. Spark Advance	Engine R.P.M.
370/400	34°	3500
400 Cyclone	36°	3500
440 Cyclone	36°	3500
460 Cyclone	36°	3500

Repair

Precautions

⚠WARNING

When Performing the following procedure, be sure to observe the following.

Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.

Be sure to keep hands, feet, and clothing clear of engine moving parts.

Do not touch or disconnect any ignition system parts while engine is running.

Do not reverse battery cable connections. System is negative (-) ground.

Do not disconnect battery cables while engine is running.

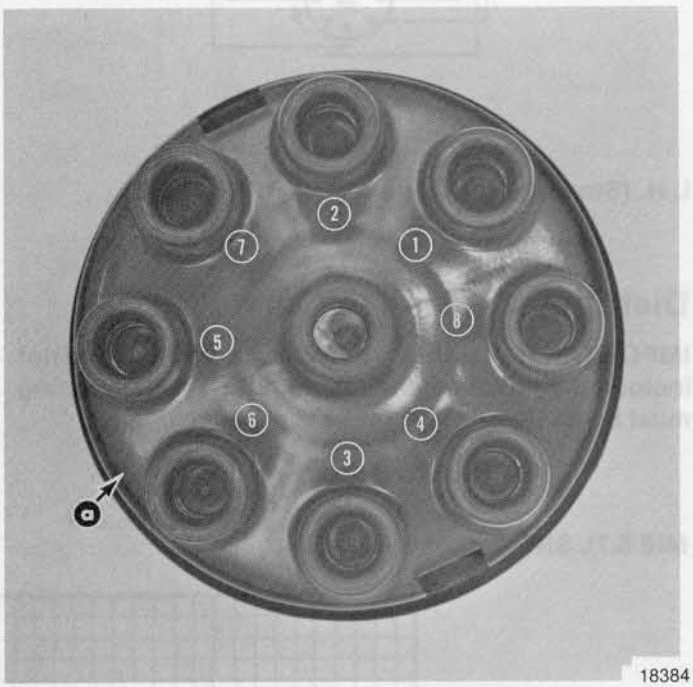
Distributor Cap and Rotor

1. Loosen distributor cap clamp retaining screws.
2. Remove distributor cap.
3. Clean cap with warm soap and water and blow off with compressed air.
4. Check cap contact for excessive burning or corrosion. Check center contact for deterioration.

IMPORTANT: Distributor caps (for marine use) should have brass contacts, aluminum contacts should not be used.

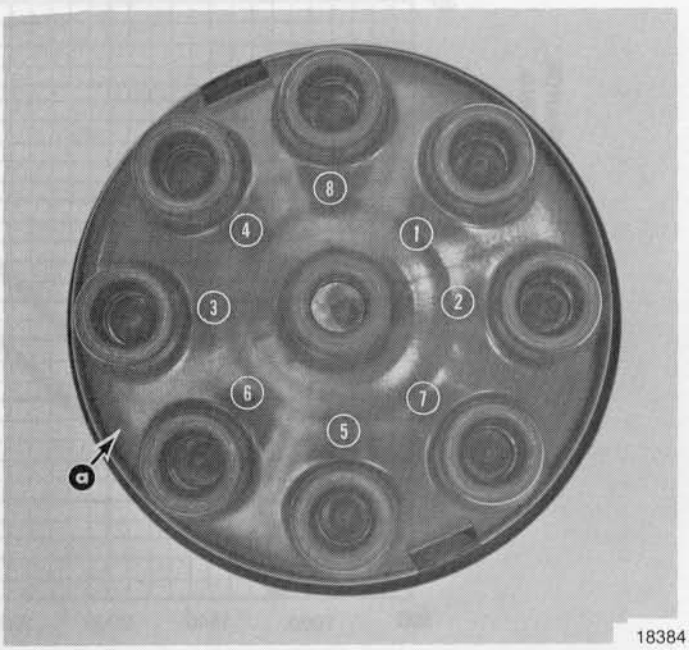
5. Check cap for cracks or carbon tracks using Magneto Analyzer.
6. Lift rotor up, off of distributor shaft.
7. Check for burned or corroded center contact.
8. Check rotor for cracks and carbon tracks using Magneto Analyzer.
9. Install rotor on shaft. Make sure to line up rotor with keyway on distributor shaft. Be sure rotor is completely seated on distributor shaft.
10. Place cap on distributor. Make sure notch on cap lines up with notch in distributor and cap is firmly seated.
11. Tighten clamp retaining screws.
12. Install spark plug wires (if removed) as shown.

Left Hand Rotation



a - Alignment Notch

Right Hand Rotation



a - Alignment Notch

Contact Points

1. Examine contact points for dirt, wear, pitting and misalignment. Dirty points should be cleaned. Normal point condition is an overall grey color on contact surface.
2. Check for point resistance. A voltage drop of less than .125 volts across points should exist. Make this check with a sensitive volt meter or point resistance meter.

Abnormal Point Wear

1. Points, which have been operated for a period of time, have a rough surface, but this may not mean that points are worn out.
2. If points burn or pit, however, they soon become unsatisfactory for further operation. Not only must they be replaced, but ignition system and engine must be checked to determine cause and elimination of trouble. Unless condition is corrected, new points will provide no better service than old points.

Cleaning of Points

1. Dirty contact points should be dressed with a few strokes of a clean, fine-cut contact file. File should not be used on other metals and should not be allowed to become greasy or dirty.

IMPORTANT: Never use emery cloth to clean contact points.

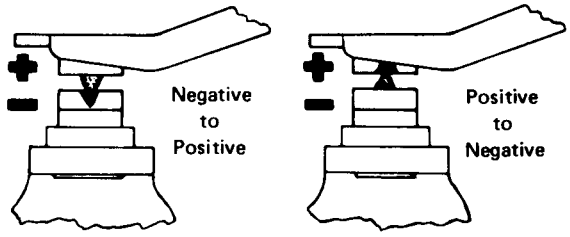
2. Contact surfaces, after considerable use, may not appear bright and smooth, but this is not necessarily an indication that they are not functioning satisfactorily. Do not attempt to remove all roughness nor dress point surfaces down smooth. Merely remove scale or dirt.
3. Badly burned or pitted contact points should be replaced and cause of trouble determined and corrected.

Burning of Points

1. Contact point burning results from high voltage, presence of oil or other foreign material, defective condenser or improper point adjustment.
2. High voltage causes excessively high current flow thru contact points which burns them rapidly. High voltage can result from improperly adjusted or inoperative voltage regulator.
3. Oil or crankcase vapors, which work up into distributor and deposit on point surfaces, cause them to burn rapidly.
4. If contact point opening is too small (cam angle too large), points will be closed too long. Average current flow thru points will be too high, so points will burn rapidly and arcing will occur between points.

Pitting of Points

1. Contact point pitting results from an out-of-balance condition in ignition system which causes transfer of material from one point to other so that a tip builds up on one point while a pit forms in other.



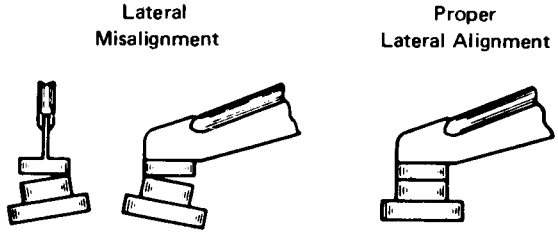
2. If points are pitted, condenser should be checked for proper capacity.

Replacement

1. Remove primary lead from primary terminal on distributor. Remove primary terminal screw and nut from distributor. (Use care not to lose the 2 insulator bushings in distributor housing). Remove condenser lead and point lead from primary terminal screw.
2. Remove contact set attaching screw and lift contact point set from breaker plate.
3. Clean oil and dirt from breaker plate.

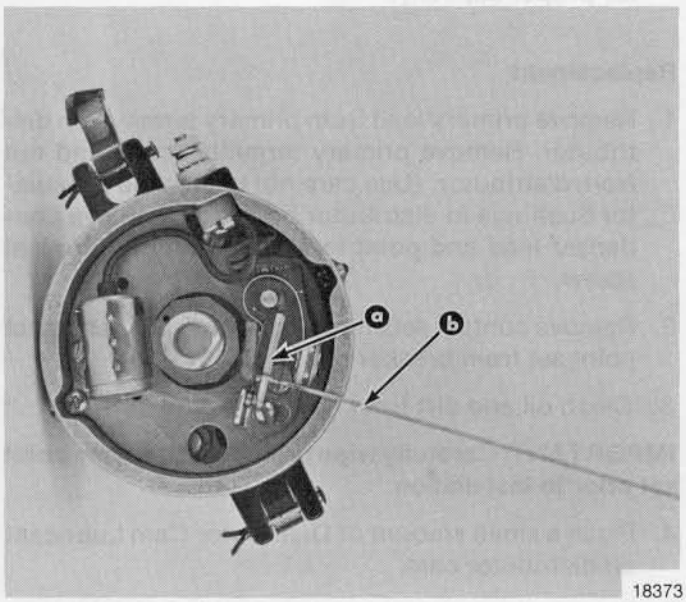
IMPORTANT: Carefully wipe protective film from point set prior to installation.

4. Place a small amount of Distributor Cam Lubricant on distributor cam.
5. Place a new contact point assembly in position on breaker plate and install attaching screw.
6. Place primary terminal screw through condenser lead and point lead. Install primary screw through 2 insulator bushings in distributor housing. Install primary terminal lock nut, primary lead, and primary lead retaining nut to primary terminal screw.
7. Check points for proper alignment. If points do not align properly, replace with another set of points.



8. Check point spring tension.

Contact point spring tension must fall within specified limits. Weak tension will cause chatter which results in arcing and burning of points and an ignition miss at high speed, while excessive tension will cause undue wear of contact points, cam and rubbing block. Contact point tension should be checked with a spring gauge. Scale should be hooked to breaker lever and pull exerted at 90° to breaker lever. Reading should be taken just as points separate. Tension can be adjusted by bending breaker lever spring. If tension is excessive, it can be decreased by pinching spring carefully. To increase tension remove lever from distributor so that spring can be bent away from lever. Avoid excessive spring distortion.



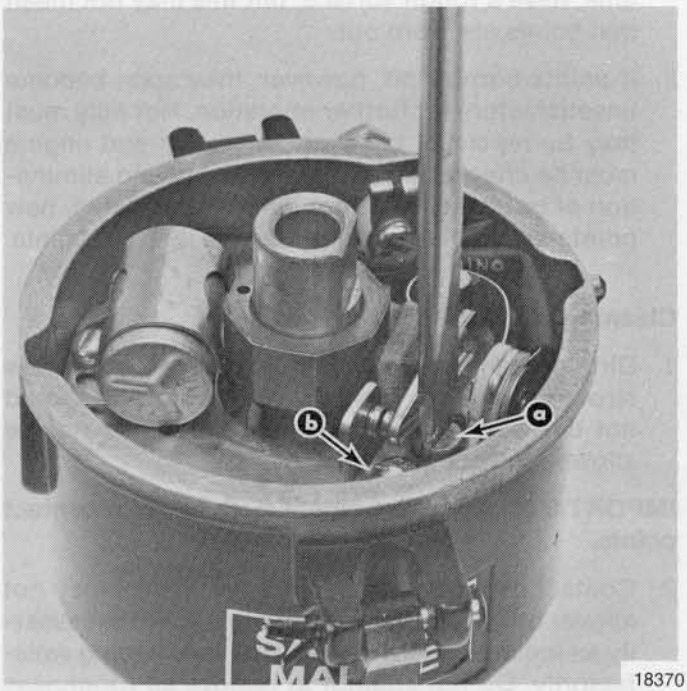
18373

a - Movable Contact
b - Spring Tension Gauge

Point Adjustment with Feeler Gauge

IMPORTANT: Point gap (dwell) can be adjusted by 2 methods. It is preferred that points be adjusted with a feeler gauge, then checked with a dwell meter. Points, however, also can be adjusted, as well as checked, with a dwell meter: After points have been set, dwell should be checked with engine running.

1. Rotate distributor until rubbing block rests on peak of cam lobe, which will provide maximum breaker point opening.
2. Insert correct feeler gauge between breaker points.
3. Loosen lockscrew and adjust points to specifications.



18370

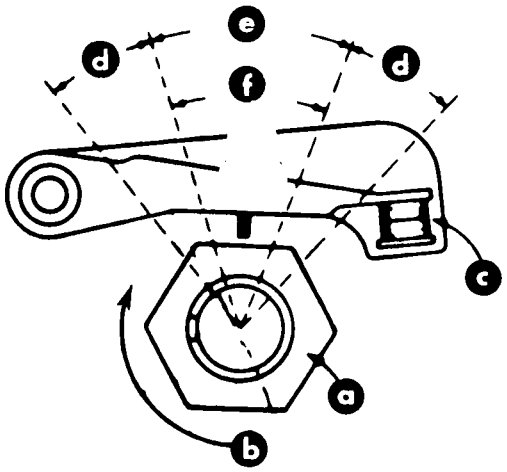
a - Adjustment Screw
b - Locking Screw

Point Adjustment

Dwell Adjustment

1. Remove distributor cap and rotor.
2. Connect positive (+) dwell meter lead to negative (-) side of coil. Connect negative (-) meter lead to ground.
3. Loosen point lock screw slightly.
4. While cranking engine with starter, adjust dwell with a screwdriver to obtain reading on dwell meter, as specified in "Specifications", and tighten lockscrew. (Dwell reading will be unsteady using this method).

IMPORTANT: Cam angle increased as point opening is decreased and vice versa.



a - Cam
b - Direction of Rotation
c - Breaker Points
d - Points Open
e - Points Close
f - Cam Angle or Dwell

5. Install rotor and distributor cap and recheck dwell with engine running.

IMPORTANT: Dwell should be checked between idle and 1750 RPM. Any dwell reading variations of more than 3° between idle and 1750 RPM would indicate wear in the distributor.

Cam angle readings, taken at speeds above 1750 engine RPM, may prove unreliable on some dwell meters.

Condenser

1. Use Magneto Analyzer for test.
2. Test condenser for the following:
   a. Condenser capacity test.
   b. Condenser leakage and short test.
   c. Coil continuity test.
   d. Primary resistance test.
   e. Secondary resistance test.
3. Replace coil if test results are not within specfications.

Coil

1. Use Magneto Analyzer for test.
2. Check coil for the following:
   a. Coil power test.
   b. Coil surface insulation test.
   c. Coil continuity test.
   d. Primary resistance test.
   e. Secondary resistance test.
3. Replace coil if test results are not within specifications.

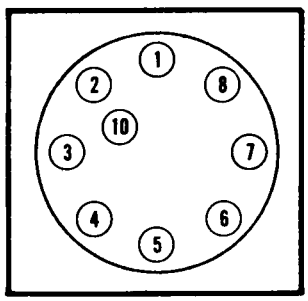
Ignition Resistance Wire

Engine with Electric Choke

1. Disconnect wire from positive (+) side of coil.
2. Unplug quick disconnect (with 2 wires) from electric choke heater element.
3. Connect ohmmeter leads to ends of disconnected wires. Replace resistor wire if reading is not within specifications.
4. Reconnect wires to coil and choke.
5. For instructions on replacing resistor wire refer to "Section 3, Part E".

Engine without Electric Choke

1. Disconnect wire from positive (+) side of coil.
2. Unplug instrumentation harness from engine harness.
3. Connect one ohmmeter lead to wire removed from coil. Connect other ohmmeter lead to No. 5 pin hole in engine harness. Replace resistor wire if reading is not within specifications.



Engine Harness Connector

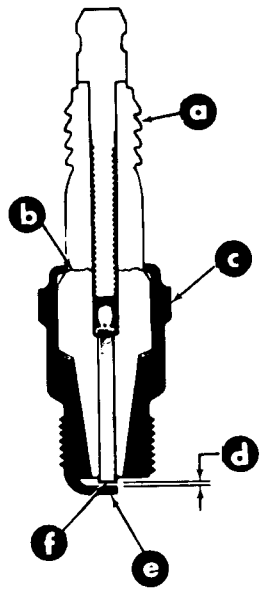
4. Reconnect wire to coil. Plug instrumentation harness onto engine harness and tighten retaining clamp securely.
5. For instructions on replacing resistor wire refer to "Section 3, Part E".

Spark Plugs

1. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.
2. Inspect each spark plug for make and heat range. All plugs must be the same make and number or heat range. Refer to "Specifications" for spark plug numbers.

IMPORTANT: Never bend the center electrode to adjust gap. Always adjust by bending ground or side electrode.

3. Adjust spark plug gaps with a round feeler gauge. Refer to "Specifications" for proper spark plug gap.



a - Porcelain Insulator
b - Insulator Cracks Often Occur at this Point
c - Shell
d - Proper Gap
e - Side Electrode (File Flat When Adjusting Gap - DO NOT Bend)

4. Clean spark plug seating area. Do not use gaskets on taper seat plugs. Install spark plugs and torque to specifications. Where used, gasket must be fully compressed to complete heat transfer and provide a gas-tight seal in cylinder. For this reason, as well as necessity of maintaining correct plug gap, correct torque is very important during installation.

IMPORTANT: Tapered seat spark plugs are not interchangeable with nontapered (with gasket) spark plugs.

High Tension Leads

1. Inspect high tension leads for damage.
2. Check high tension leads for continuity.
3. Replace any leads that are cracked, cut, or have damaged spark plug boots.
4. Replace any leads that do not show continuity from end to end.
5. Reinstall high tension leads in proper order.

IMPORTANT: Proper positioning in high tension lead supports is important to prevent cross firing.

Distributor Repair

Removal

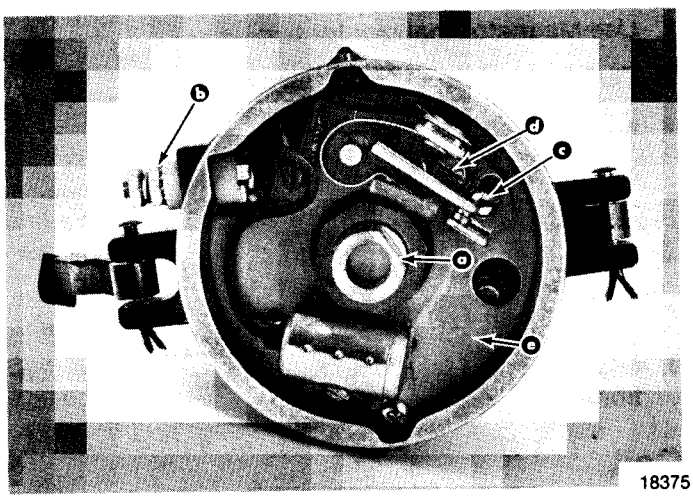
1. Remove distributor cap (2 screws) and gasket. Do not remove plug wires from cap unless necessary.
2. Disconnect coil primary lead from distributor.
3. Crank or turn engine slowly. Align timing marks when rotor is pointing to No. 1 terminal of distributor cap. If same distributor is to be reinstalled in engine, mark position of distributor housing in relation to engine so that distributor may be installed in same position.
4. Remove distributor retaining clamp.
5. Remove distributor.

IMPORTANT: To simplify distributor installation, do not turn crankshaft with distributor removed from engine.

Disassembly

IMPORTANT: It is not necessary to disassemble distributor any further than required to complete repairs.

1. Lift rotor off of distributor shaft.
2. Remove condenser and breaker points and test as previously outlined.
3. Mark breaker plate location and remove 2 retaining screws. Remove breaker plate.



18375

a - Rotor Alignment Notch
b - Primary Terminal
c - Breaker Point Attaching Screw
d - Breaker Point Adjustment Screw
e - Breaker Plate

4. Remove pin from driven gear and shaft and remove gear from shaft.
5. Remove washer(s) from shaft. (If there are 2 washers, the steel washer goes towards housing and the brass washer towards gear.)

IMPORTANT: Housing bushings are not serviced separately. (Refer to parts manual).

6. Check for side play between shaft and housing bushings. Maximum side play is .002" (.05mm).
7. Remove and check shaft for being bent by placing in V-blocks and checking run out with a dial indicator. Maximum run out allowed is .002" (.05mm) (retain washer between advance mechanism and distributor housing).
8. Check cam lobes for wear and cam should fit tight on shaft. Advance plate should fit tight on shaft.

IMPORTANT: Shaft, advance mechanism and cam are serviced as an assembly and should not be disassembled. (Refer to parts manual).

9. Check advance mechanism for free movement. Mechanism should return freely when released.

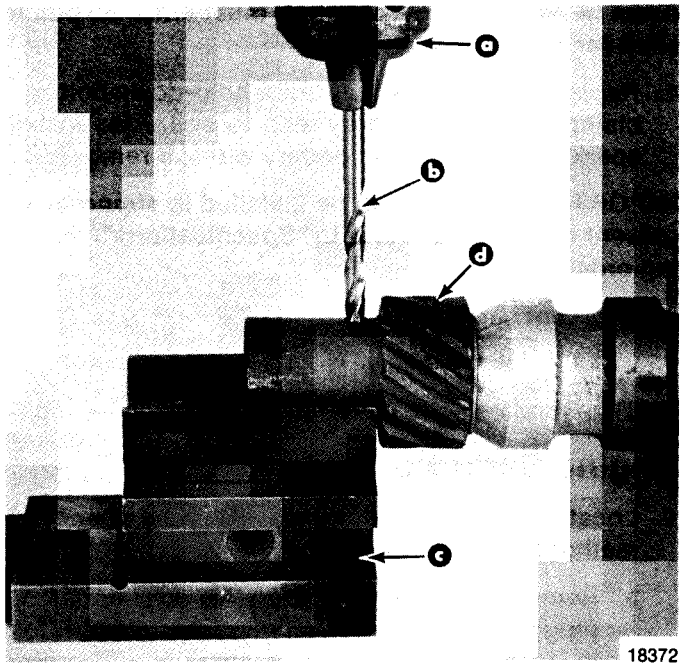
Reassembly

1. Install washer on shaft assembly and lubricate shaft with engine oil. Install shaft in housing.
2. Install washer(s) on shaft between housing and gear (if there are 2 washers, steel goes toward housing and brass goes toward gear).
3. If installing original driven gear slide onto shaft and install roll pin.

IMPORTANT: Hole in gear is offset, gear will fit on shaft and line up with hole only one way.

4. If installing a new driven gear the gear will not come drilled all the way through. Install gear on shaft. Turn gear to line up the hole with the hole in shaft. Using hole in gear and hole in shaft as a guide, drill through other side of gear with a 3/16" carbide tipped drill, install roll pin.

IMPORTANT: If new gear has only a dimple, you will have to drill through one side of the gear before you slide gear onto shaft. In most cases it is recommended to have a machine shop complete the drilling operation for new gear installation.



a - Drill Press
b - 3/16" Carbide Tip Drill
c - V-Block
d - New Gear

5. Install breaker plate using alignment mark to properly locate.
6. Install points, condensor, and primary terminal screw.
7. Install distributor as outlined in "Distributor Installation".

Distributor Installation

Engine Not Disturbed

1. Install new gasket on distributor housing.
2. Turn rotor approximately 1/8-turn in a counterclockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor positioned as noted during removal.

IMPORTANT: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.

4. Replace and tighten distributor hold-down bolt and clamp. Connect primary lead to coil. Also install spark plug and coil secondary wires, if removed.

IMPORTANT: Wires must be installed in supports, to prevent cross-firing. Refer to "Specifications", for firing order.

5. Set point gap and dwell.
6. Install rotor and cap.
7. Time ignition as outlined under "Ignition Timing".

Engine Disturbed

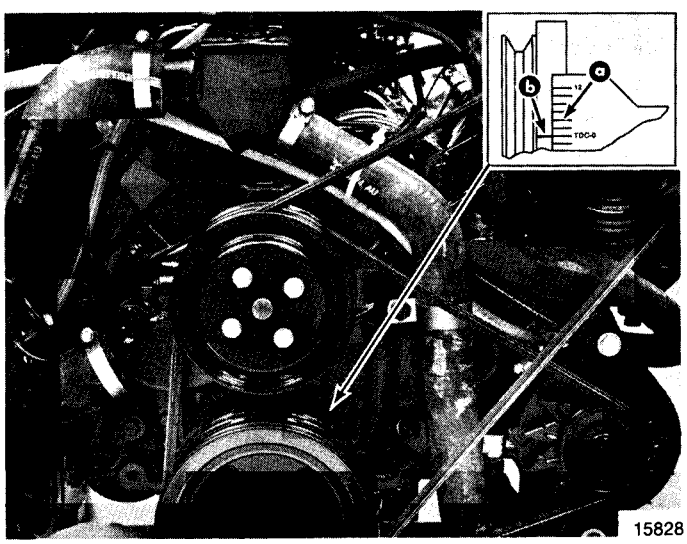
1. Locate No. 1 piston in firing position by either of 2 methods.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley or. . .
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward No. 1 cylinder on cap (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, engage starter a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Turn distributor body slightly until points just open and tighten distributor clamp bolt.
6. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug.
7. Install cap, distributor primary lead to coil. Check all high tension wire connections and connect spark plug wires, if they have been removed. Wires must be installed in their proper location in supports to prevent cross-firing. Refer to "Specifications" for firing order.
8. Set point gap and dwell.
9. Time ignition as outlined under "Ignition Timing".

Ignition Timing

IMPORTANT: Dwell must be set to specification before adjusting timing.

1. Connect timing light to No. 1 spark plug. Connect power supply leads on light to battery (12 volts). Refer to "Specification" for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at normal idle speed.
4. Aim timing light at timing tab, located on timing gear cover and crankshaft harmonic balancer.

IMPORTANT: GM engine timing marks (on tab) are in 2° increments. MCM and MIE L.H. engines will have the "A" (Advance) mark to the left of "O". MIE R.H. engines will have the "A" mark to the right of "O". Timing must be set on the "A" side of "O" (Top Dead Center).



a - Degree Marks
b - Timing Marks

Timing Tab on "GM" V-8 Engine

5. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on balancer or pulley lines up with mark on tab specified in "Specifications". Tighten clamp and recheck location of timing mark.
6. Stop engine and remove timing light.

Thunderbolt IV (HEI) System

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)
Distributor Clamp 3/8 - 16	20 (27)
Spark Plugs (14mm)	15 (20)

Tools/Lubricants/Sealants

TOOLS	
91-52024A1	Remote Starter Switch
91-63998	Spark Gap Tester
91-99379	Timing Light
91-63209	Torch Lamp
91-99750	Volt/Ohmmeter

LUBRICANTS/SEALANTS	
92-90018	2-4-C Lubricant
92-41669	Insulating Compound
92-25711	Liquid Neoprene
92-32609	Quicksilver Loctite "A"

Specifications

UNIT OF MEASUREMENT
In. (mm)

COIL

Coil Part Number	392-7803
Primary Resistance*	.60 - .80 Ohms
Secondary Resistance*	9,400 - 11,700 Ohms

*NOTE: * Use magneto analyzer*

TIMING

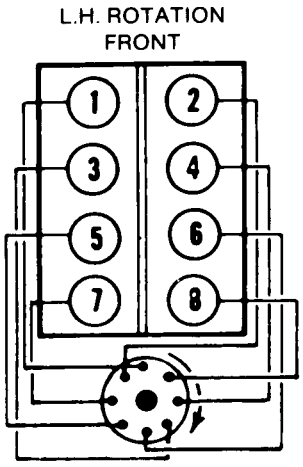
Model	MCM 200, 230, 260, 300 330 BW, 350 5.0 Litre, 5.0 Litre LX 5.7 Litre, 350/454 Magnum	MIE 230, 260, 340 5.0 Litre, 5.7 Litre, 7.4 Litre	MCM 370/420/575	MCM 320 EFI
Timing	8° BTDC		10° BTDC	12° BTDC

SPARK PLUGS

Model	MCM Models, MIE Models, Production Performance Models Litre Models, Magnums			MCM 300, 320 EFI
Spark Plug Gap	.035 (.9)			.032 (.8mm)
Spark Plug Type	AC-MR44T RV8C	AC-MR43T/Champion-RV8C (Note 1)	AC-MR44T RV8C	AC-MR43T RV8C

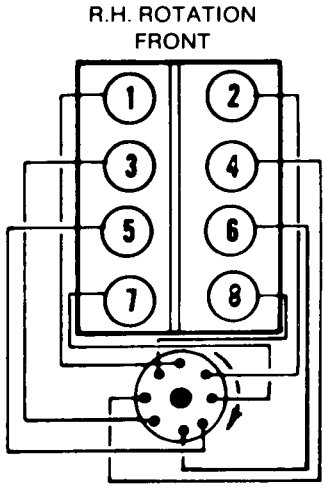
NOTE 1: 460/575 spark plugs use: AC-MR41T or equal.

FIRING ORDER



FIRING ORDER
1-8-4-3-6-5-7-2

ALL MCM/MIE L.H. (Standard) Rotation Models



FIRING ORDER
1-2-7-5-6-3-4-8

MIE R.H. (Opposite) Rotation

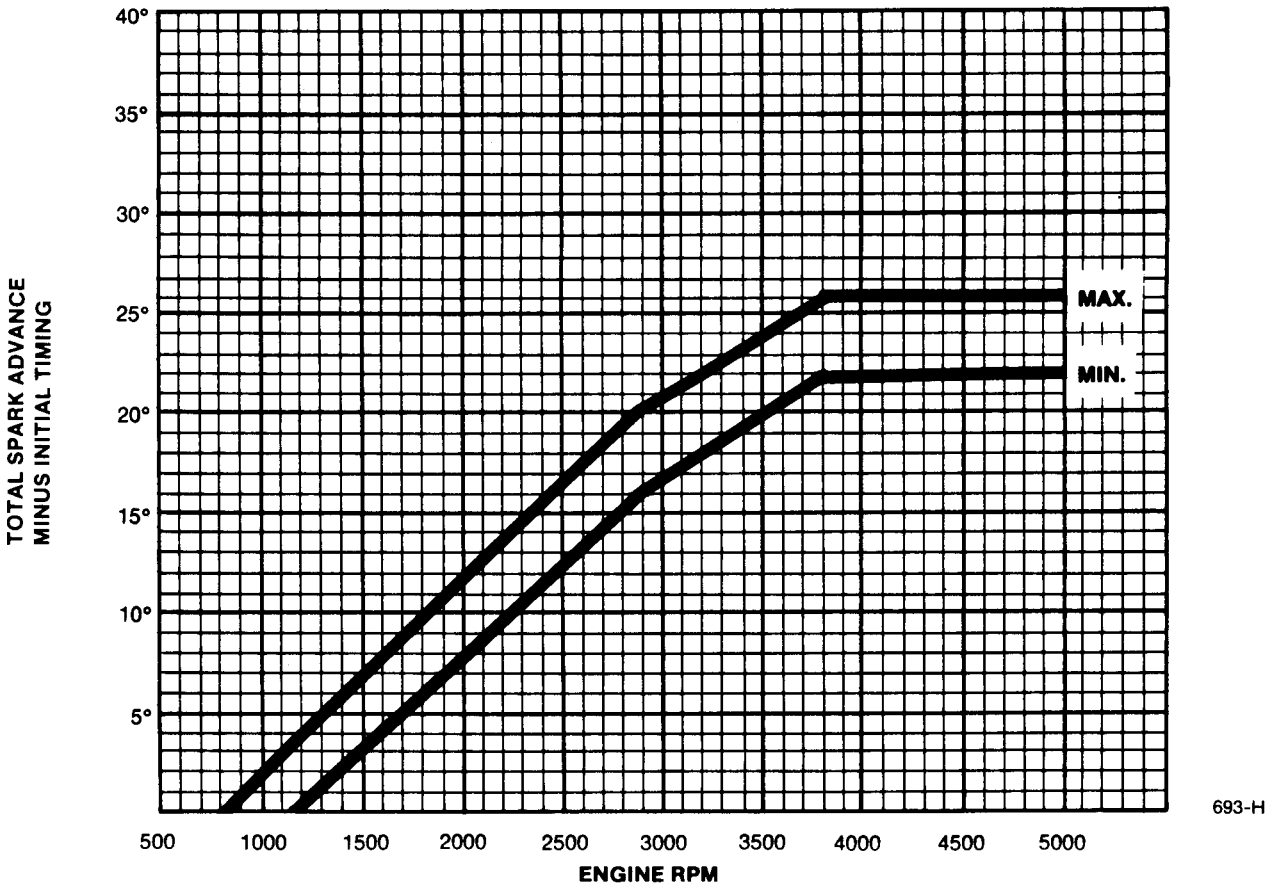
Distributor Advance Curve

IMPORTANT: Distributor advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve.

EXAMPLE: On the advance curve chart a 260 shows 19° spark advance at 2900 R.P.M. Add 8° BTDC initial timing for a 260 and total spark advance at 2400 R.P.M. is 25°.

IMPORTANT: On the HEI ignition the spark advance is controlled by the amplifier.

MCM 200/230/260/300/330 BW/350 MAGNUM/ 370TR/454 MAGNUM/230TR/260TR MIE 230/260/340 5.0 Litre, 5.0 Litre LX, 5.7 Litre, 7.4 Litre, 320 EFI



Repair

Precautions

⚠WARNING

When performing the following procedure, be sure to observe the following.

Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.

Be sure to keep hands, feet, and clothing clear of engine moving parts.

Do not touch or disconnect any ignition system parts while engine is running.

Do not reverse battery cable connections. System is negative (-) ground.

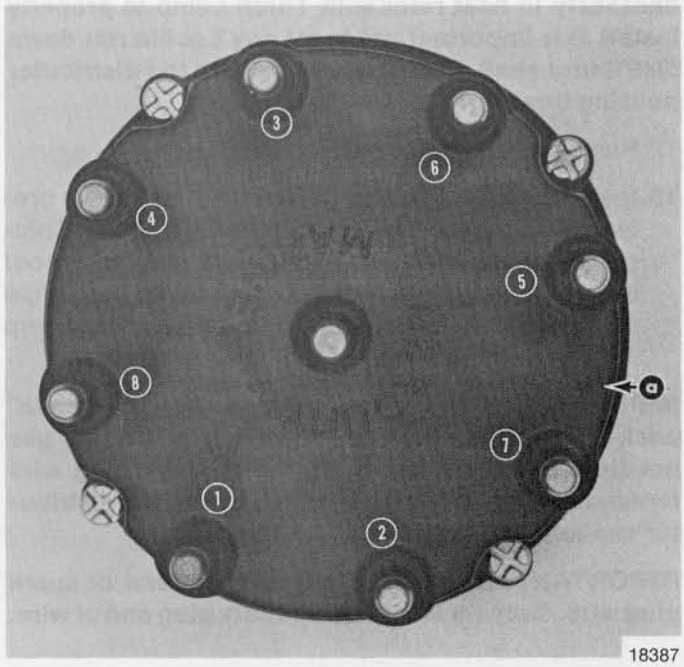
Do not disconnect battery cables while engine is running.

Distributor Cap

1. Loosen four distributor cap retaining screws.
2. Remove distributor cap.
3. Clean cap with warm soap and water and blow off with compressed air.
4. Check cap contact for excessive burning or corrosion. Check center contact for deterioration.
5. Check cap for cracks or carbon tracks using Magneto Analyzer.

IMPORTANT: If high tension leads are removed from cap refer to Figures following for installation.

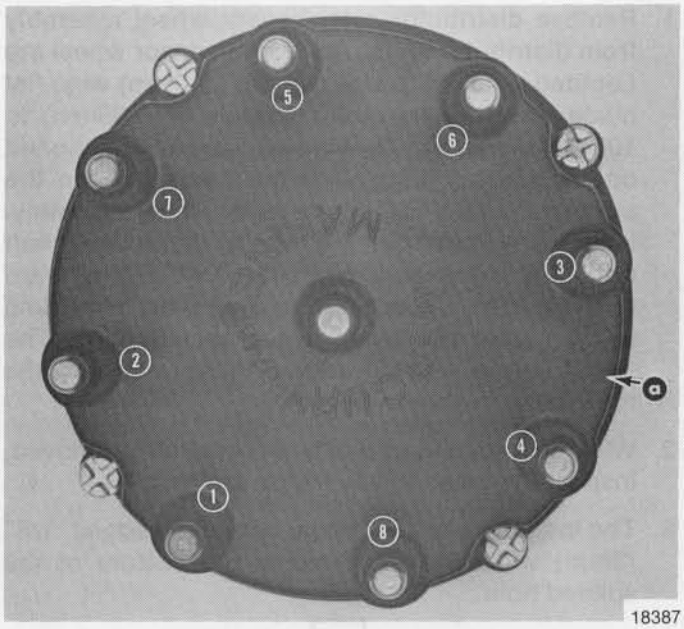
L.H. Rotation Wiring



18387

a - Alignment Notch

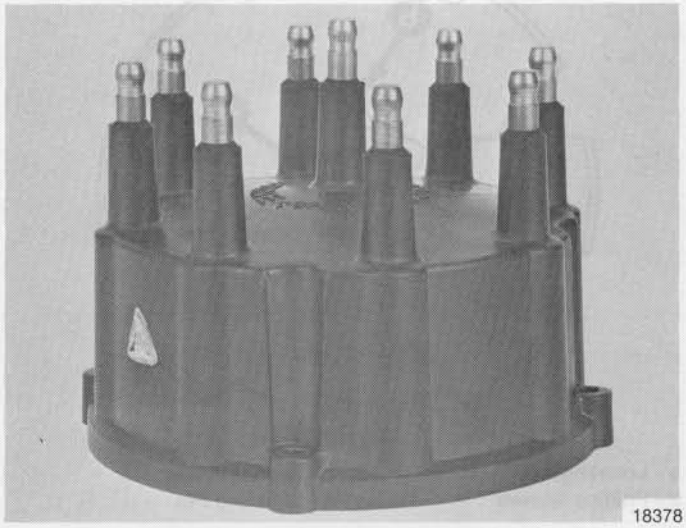
R.H. Rotation Wiring



18387

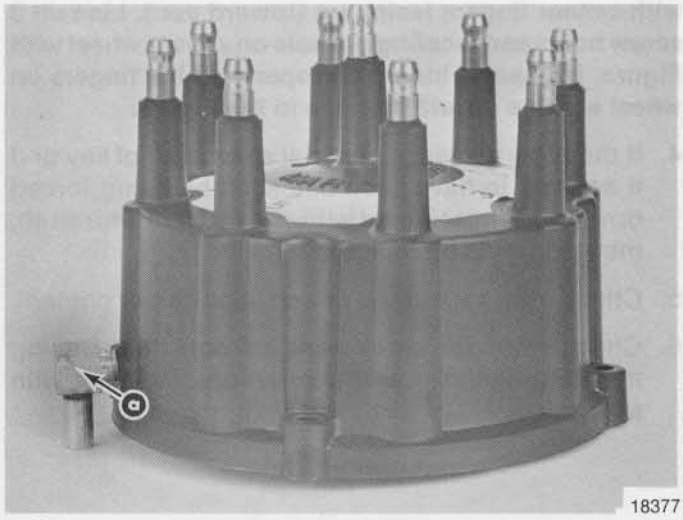
a - Alignment Notch

Non Vented Cap



18378

Vented Cap

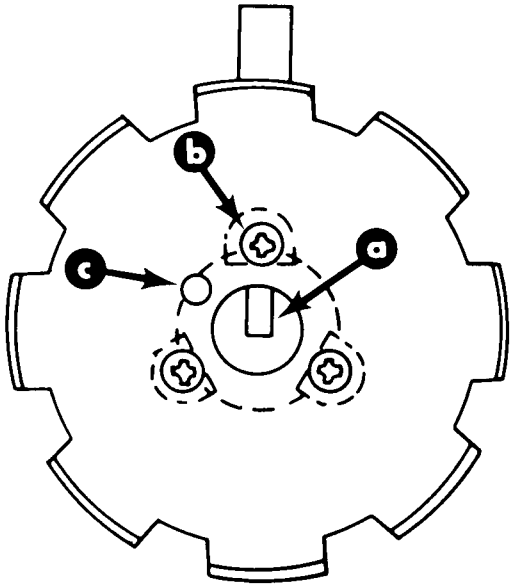


18377

a - Vent

Rotor and Sensor Wheel

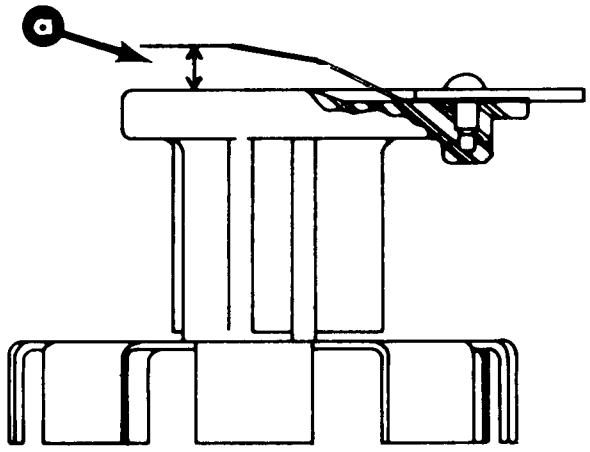
1. Remove distributor rotor/sensor wheel assembly from distributor shaft. Rotor and sensor wheel are Loctited onto shaft. Use two 3/8" (10mm) wide flat blade screwdrivers approximately 8" (203mm) to 10" (254mm) long. The screwdrivers are positioned opposite each other with the blade tips on the underside of the rotor and sensor wheel assembly. Make sure blade tips are toward distributor shaft until they come in contact with shaft. A downward push on both screwdriver handles at the same time will pry rotor and sensor wheel assembly off. The use of Torch Lamp will also aid in the removal of the rotor/sensor wheel assembly.
2. With the rotor and sensor wheel assembly removed, inspect the locating key inside the rotor.
3. The locating key will appear as a clean edged, 1/8" (3mm) wide, sloped ramp at the bottom of the splined hole.



a - Locating Key
b - Phillips Screws
c - Sensor Wheel
d - Locating Pin

IMPORTANT: If there is any doubt if sensor wheel is located properly, lay sensor wheel on top of Figure with sensor fingers facing up (toward you). Line up 3 screw holes and locating pin hole on sensor wheel with Figure. If wheel is indexed properly all the fingers on wheel will line up with the one in the Figure.

4. If there are pieces of material shaved off of key or if it appears to have been damaged by being forced down while misaligned with slot in distributor shaft, the rotor must be replaced.
5. Check rotor for burned or corroded center contact.
6. Check rotor for cracks and carbon tracks using magneto analyzer and instructions supplied with analyzer.
7. If rotor is damaged, replace rotor by removing 3 phillips screws and separating sensor wheel from rotor. Reinstall sensor wheel to new rotor making sure locating pin on rotor is installed in locating hole in sensor wheel. Tighten 3 phillips screws securely.
8. Bend carbon brush tang upward slightly until a distance of 1/4" (6.5mm) is obtained between rotor and tang.



a - 1/4" (6.5mm)

9. Put 2 drops of Loctite 271 or Loctite Type "A" into the rotor so it lands on the locating key.
10. Put 2 drops of Loctite in keyway on upper portion of distributor shaft.
11. Immediately install rotor assembly onto distributor shaft. Make sure rotor locating key is aligned with keyway in distributor shaft before pressing rotor all the way down on shaft until it stops with the palm of your hand. Let Loctite cure overnight with distributor in inverted position.

IMPORTANT: The rotor should fit very tight. It may be necessary to heat rotor with Torch Lamp to properly install. It is important not to let any Loctite run down distributor shaft. Loctite could get into top distributor housing bushing.

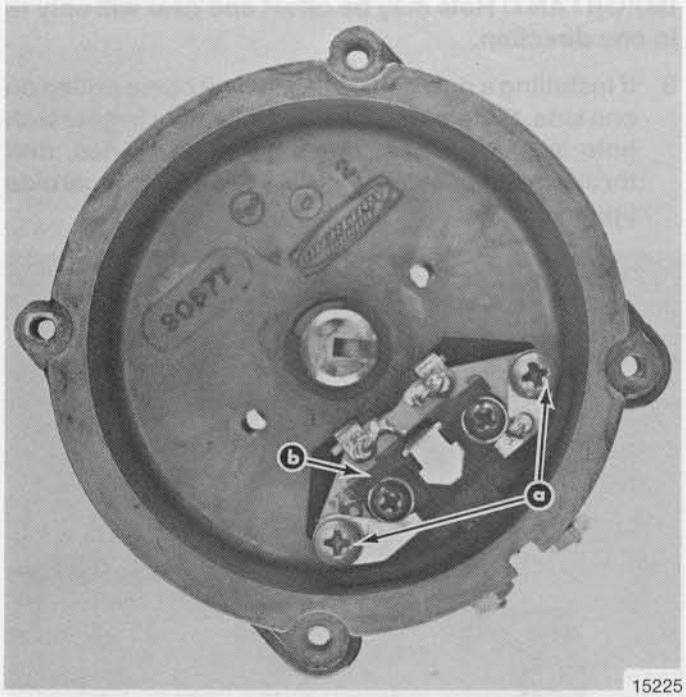
12. Reinstall distributor cap on distributor.
13. Install spark plug wires (if removed) as shown previously. Apply a small quantity of Insulating Compound to the inside of each spark plug wire boot before installing the boot on distributor cap. Wipe off excess. This Insulating Compound will help "waterproof" this area of the ignition system.

IMPORTANT: Make sure boot does not "hydraulic" back off of distributor cap terminal. If it does, use needle nose pliers and bend metal spark plug wire terminal (inside of boot) slightly so it grips the distributor cap terminal tighter.

IMPORTANT: Black boot is distributor end of spark plug wire. Gray (or Red) boot is spark plug end of wire.

Sensor

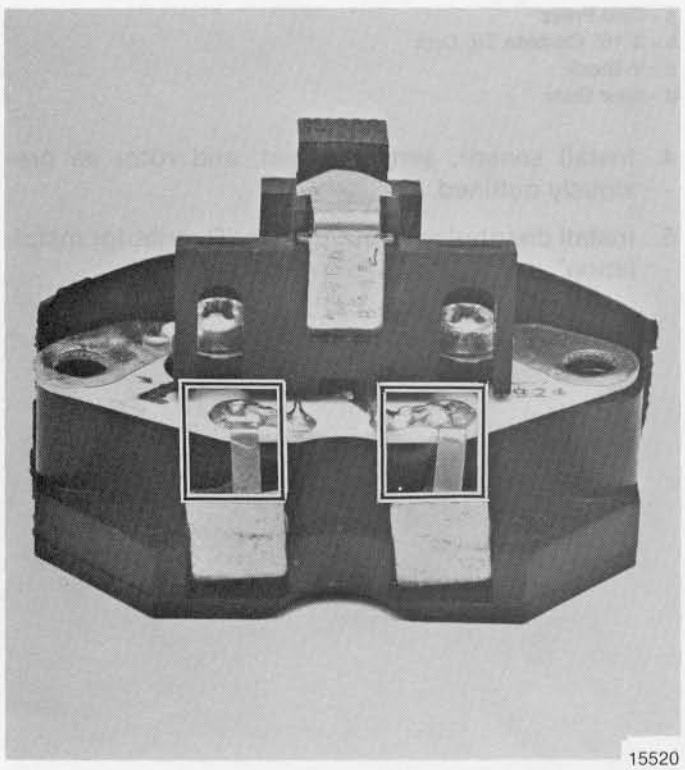
1. Remove rotor and sensor wheel.
2. Remove 2 screws that hold sensor into distributor housing.
3. Remove sensor from housing.



15225

a - Mounting Screws
b - Sensor Assembly

4. Use a magnifying glass and light to inspect the two metal "jumper leads" for cracks. If a crack is found in either metal "jumper lead", install a new sensor.



15520

⚠CAUTION

Do not use any type of silicone sealer on the inside of the distributor. Most silicone sealers give off an acidic vapor during the curing stage of the sealer. This acid can cause corrosion on the ignition components.

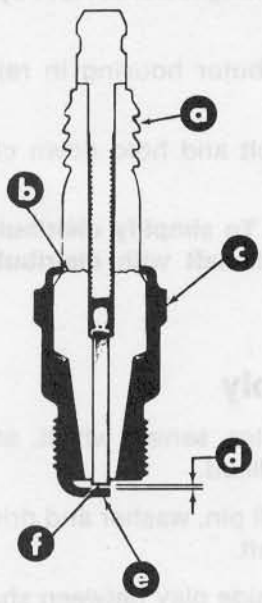
5. Install sensor into housing and install 2 retaining screws.
6. Install sensor wheel, rotor, and distributor cap.

Spark Plugs

1. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.
2. Inspect each spark plug for make and heat range. All plugs must be the same make and number or heat range. Refer to "Specifications" for spark plug numbers.

IMPORTANT: Never bend the center electrode to adjust gap. Always adjust by bending ground or side electrode.

3. Adjust spark plug gaps with a round feeler gauge. Refer to "Specification" for proper spark plug gap.



a - Porcelain Insulator
b - Insulator Cracks Often Occur at this Point
c - Shell
d - Proper Gap
e - Side Electrode (Bend to Adjust Gap)
f - Center Electrode (File Flat When Adjusting Gap - Do Not Bend)

4. Clean spark plug seating area. Do not use gaskets on taper seat plugs. Install spark plugs and torque to specifications. Where used, gasket must be fully compressed to complete heat transfer and provide a gas-tight seal in cylinder. For this reason, as well as necessity of maintaining correct plug gap, correct torque is very important during installation.

IMPORTANT: Tapered seat spark plugs are not interchangeable with nontapered (with gasket) spark plugs.

High Tension Leads

1. Inspect high tension leads for damage.
2. Check high tension leads for continuity.
3. Replace any leads that are cracked, cut, or have damaged spark plug boots.
4. Replace any leads that do not show continuity from end to end.
5. Reinstall high tension leads in proper order.

IMPORTANT: Proper positioning in high tension lead supports is important to prevent cross-firing.

IMPORTANT: Black boot is distributor end of spark plug wire. Gray (or Red) boot is spark plug end of wire.

Distributor Repair

Removal

1. Remove distributor cap. Do not remove high tension leads unless necessary.
2. Crank engine over until timing marks line up and rotor is pointing towards No. 1 cylinder on distributor cap.
3. Mark distributor housing in reference to engine block.
4. Remove bolt and hold down clamp and remove distributor.

IMPORTANT: To simplify distributor installation, do not turn crankshaft with distributor removed from engine.

Disassembly

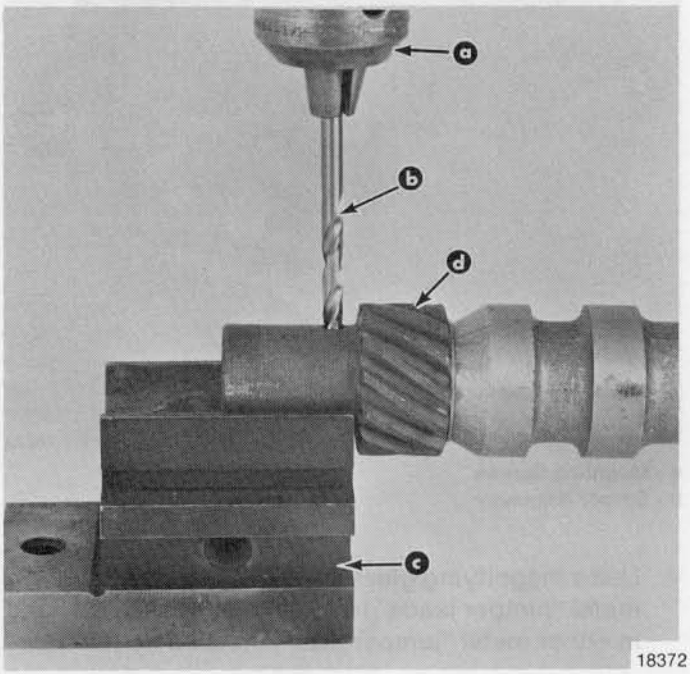
1. Remove rotor, sensor wheel, and sensor as previously outlined.
2. Remove roll pin, washer and driven gear from distributor shaft.
3. Check for side play between shaft and distributor housing bushings. Maximum side play is .002" (.05mm).
4. Remove shaft from housing and check shaft for being bent with a dial indicator and V-blocks. Maximum runout is .002" (0.5mm).

Reassembly

1. Lubricate shaft with engine oil. Install "E" clip (if removed) on shaft. Install shaft in housing.
2. Install washer on shaft. Install original gear slide onto shaft and install roll pin.

IMPORTANT: Hole may be offset and gear will only fit in one direction.

3. If installing a new gear, the gear will come drilled on one side. Slide gear onto shaft, line hole in gear with hole in shaft. Using these holes as guides, drill through other side of gear with a 3/16" carbide tipped drill.



a - Drill Press
b - 3/16" Carbide Tip Drill
c - V-Block
d - New Gear

4. Install sensor, sensor wheel, and rotor as previously outlined.
5. Install distributor as outlined in "Distributor Installation".

Distributor Installation

Engine Not Disturbed

1. Install new gasket on distributor housing.
2. Turn rotor approximately 1/8-turn in a counterclockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor positioned as noted during removal.

IMPORTANT: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.

4. Replace and tighten distributor hold-down bolt and clamp. Connect leads. Also install spark plug and coil secondary wires, if removed.

IMPORTANT: Wires must be installed in supports, to prevent cross-firing. Refer to "Specifications", for firing order.

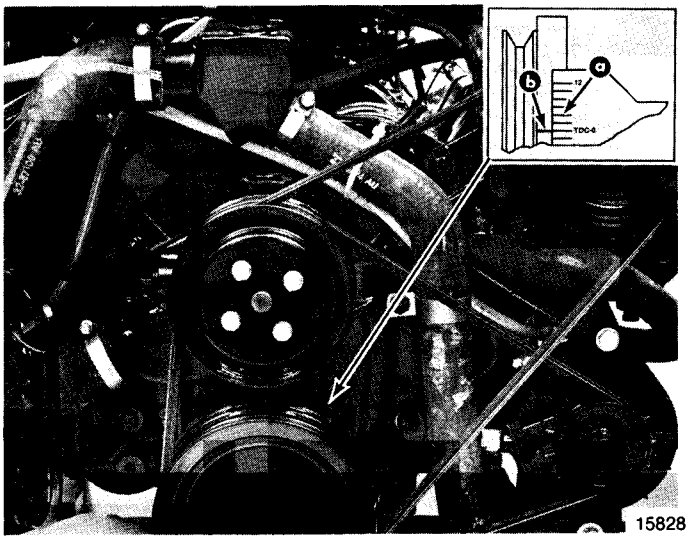
5. Install cap.
6. Time ignition as outlined under "Ignition Timing".

Engine Disturbed

1. Locate No. 1 piston in firing position by either of 2 methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley or . . .
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward No. 1 cylinder on cap (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more and push distributor down to engage camshaft. It may be necessary to rotate slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, engage starter a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug.
6. Install cap and distributor leads. Check all high tension wire connections and connect spark plug wires, if they have been removed. Wires must be installed in their proper location in supports to prevent cross-firing. Refer to "Specifications" for firing order.
7. Time ignition as outlined under "Ignition Timing".

Ignition Timing

1. Connect timing light to No. 1 spark plug. Connect power supply leads on light to battery (12 volts). Refer to "Specifications" for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at normal idle speed.
4. Aim timing light at timing tab, located on timing gear cover and crankshaft harmonic balancer.



a - Degree Marks
b - Timing Mark

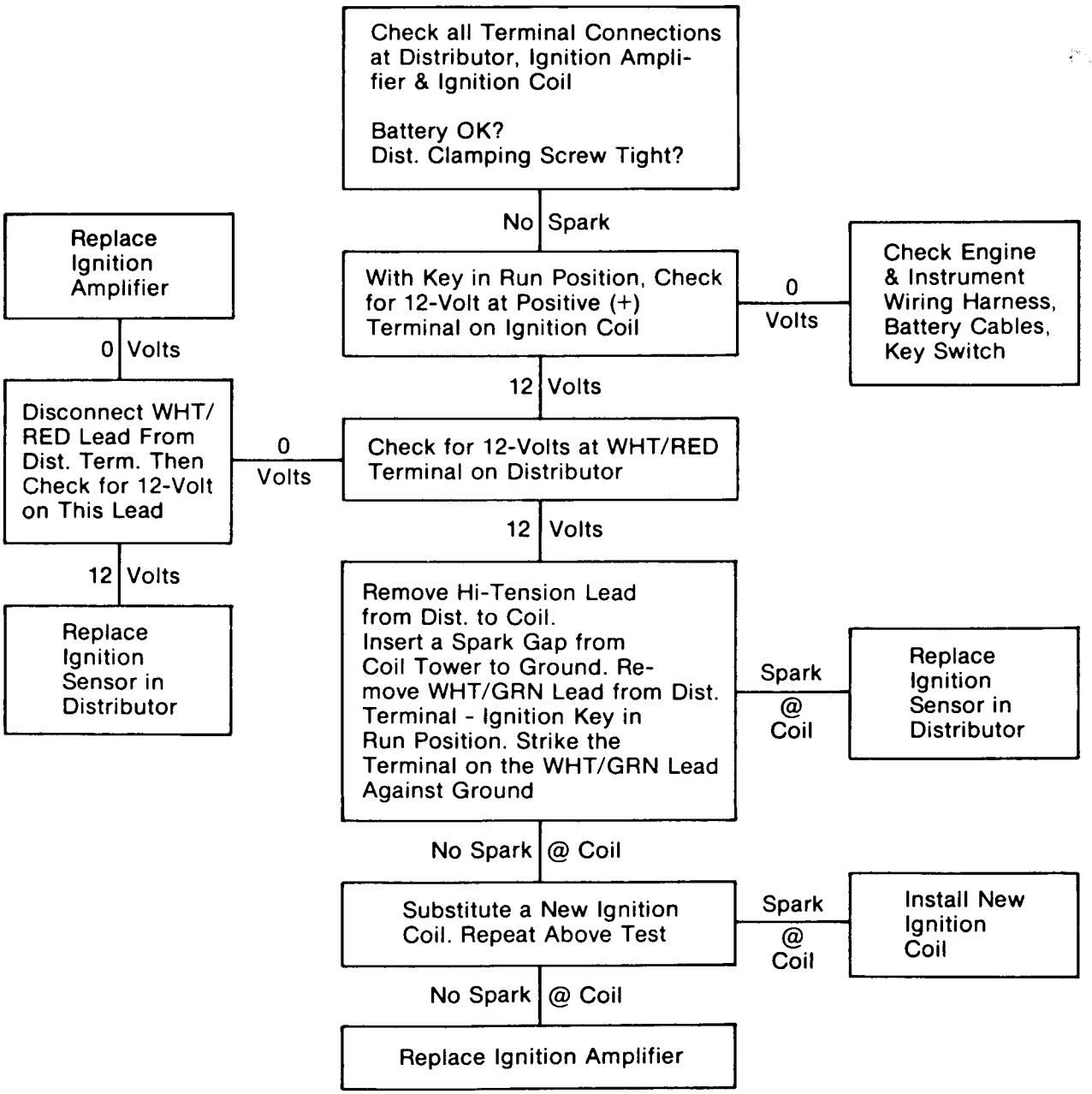
5. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on balancer or pulley lines up the mark on tab specfied in "Specifications". Tighten clamp and recheck location of timing mark.
6. Stop engine and remove timing light.

IMPORTANT: GM engine timing marks (on tab) are in 2° increments. MCM and MIE L.H. engines will have "A" (Advance) mark to left of "O". MIE R.H. engines will have the "A" mark on the right of "O". Timing must be set on the "A" side of "O" (Top Dead Center).

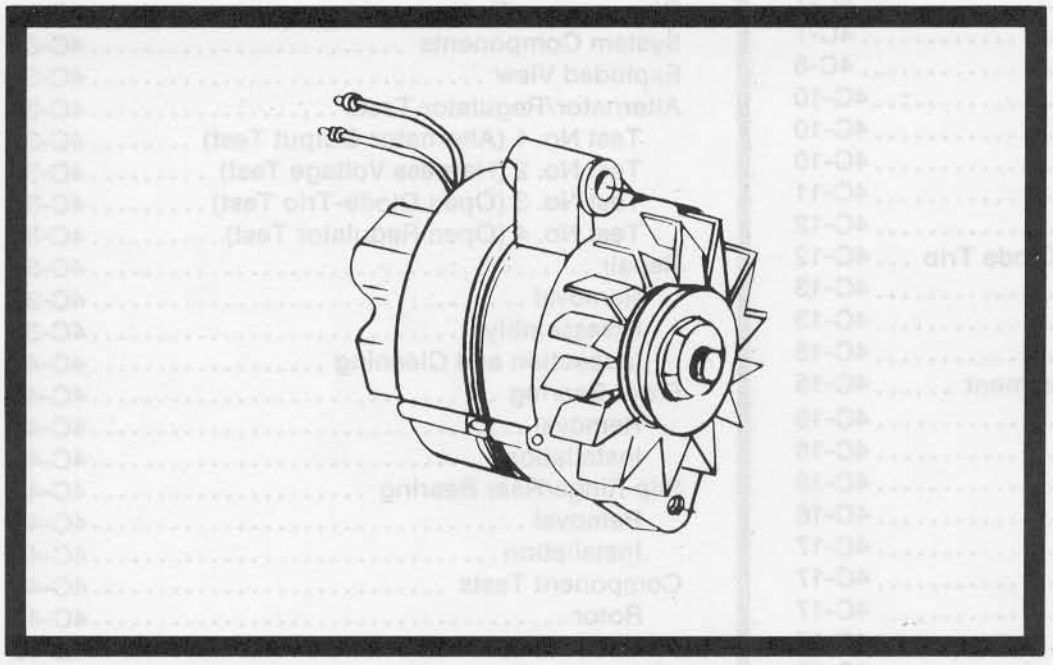
Testing HEI System

⚠WARNING

Be sure that engine compartment is well ventilated and that there are no gasoline vapors present during the following test - to prevent a potential fire hazard.



ELECTRICAL SYSTEM



4

C

CHARGING SYSTEM

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MANDO ALTERNATOR

SPECIFICATIONS

Excitation Circuit	1.3 to 2.5 Volts
Current Output	50 Amp. Min.
Voltage Output	13.9 to 14.7 Volts
Condenser Capacity	.5 MFD

TORQUE SPECIFICATIONS

FASTENER LOCATION	LBS. FT. (N.m)	LBS. IN. (N.m)
End Frame Screws		50-60 (6-7)
Brush Set Screws		16-20 (1-2)
Regulator Mounting Screws		40-45 (4-5)
Regulator Leads		20-30 (2-3)
Ground Terminal Nut		20-30 (2-3)
Pulley Nut	35-50 (48-68)	
Alternator Brace to Alternator		192 (28)
Alternator Brace to Block	30 (41)	
Alternator to Mounting Bracket	35 (48)	
Alternator Mounting Bracket	30 (41)	
V-Belt Tension (Note 1)	Depress 1/2 In.	

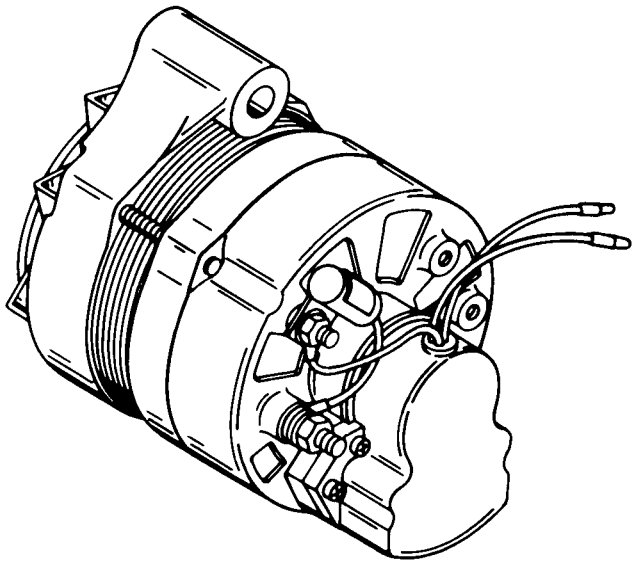
NOTE 1: Depress belt with Thumb at Midway Point between Circulating Pump Pulley and Alternator

SPECIAL TOOLS

91-76032	Magneto Analyzer
91-93572	Volt/Ohm Meter

Identification

Mando



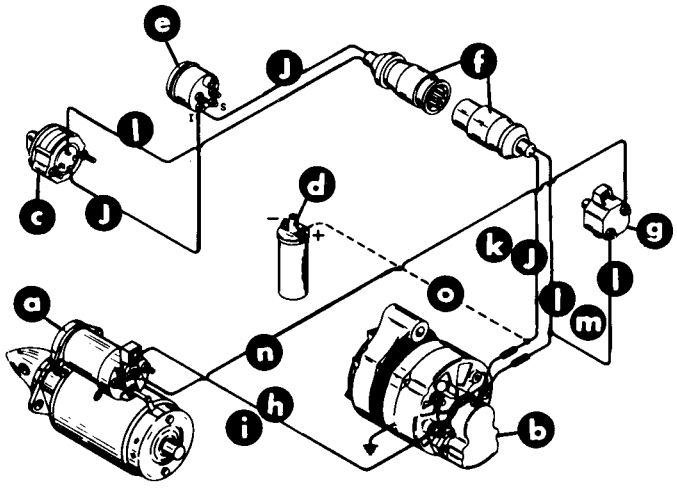
Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

System Components

The alternator system, used on engines with Mando Alternators consists of the alternator, battery, the ignition switch and the wiring which connects these components.



a - Starter
b - Alternator
c - Ignition Switch
d - Coil
e - Battery Meter
f - Harness Plug
g - Circuit Breaker
h - Orange
i - Output Lead
j - Purple
k - Excitation Lead
l - Red/Purple
m - Sensing Lead
n - Red
o - Resistance Wire

Precautions

The following precautions must be observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. Do not attempt to polarize the alternator.
2. Do not short across or ground any of the terminals on the alternator, except as specifically instructed.
3. Never disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. Never disconnect regulator lead from alternator regulator terminal when the alternator is being driven by engine.
5. Always remove negative (-) battery cable from battery before working on alternator system.
6. When installing battery, be sure to connect the negative (-) (grounded) battery cable to negative (-) battery terminal and the positive (+) battery cable to positive (+) battery terminal.
7. If a charger or booster battery is to be used. Be sure to connect it in parallel with existing battery (positive to positive; negative to negative).

Diagnosis

The alternator employs a rotor, which is supported in 2 end frames by ball bearings, and is driven (via a pulley) at approximately twice engine speed. The rotor contains a field winding that is enclosed between 2 multiple-finger pole pieces. The ends of the field winding are connected to 2 brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between the 2 end frames. It consists of 3 windings wound 120° electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains 6 diodes which are arranged so that current flows from ground, thru the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator also is not required, as the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifier and stator. A capacitor also is utilized to protect the rectifier system from high voltages and to suppress radio noise.

1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery. Battery must be at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery, before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt and replace if necessary. Also, check tension and adjust if necessary, as outlined under "Drive Belt Replacement and Adjustment".

Diagnosis on Engine

Before proceeding with the tests, perform the following checks to eliminate possible problem areas. Also observe "Precautions," immediately preceding, to prevent damage to alternator system.

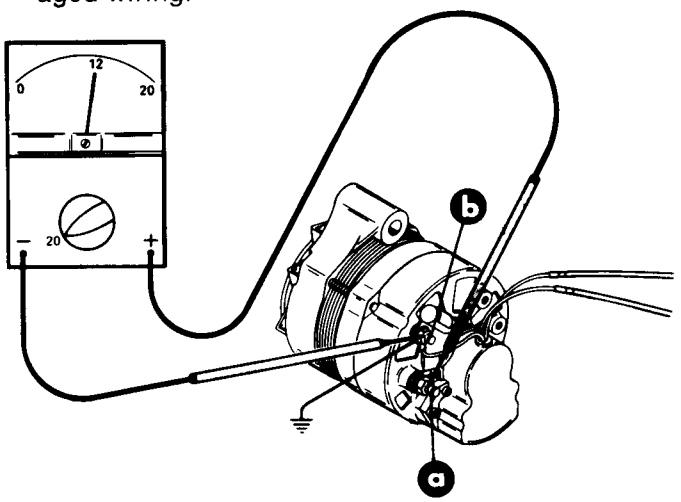
1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery. Battery must be at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt and replace if necessary. Also, check tension and adjust if necessary, as outlined under "Drive Belt Replacement and Adjustment."

ALTERNATOR SYSTEM CIRCUITRY TEST

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

Output Circuit

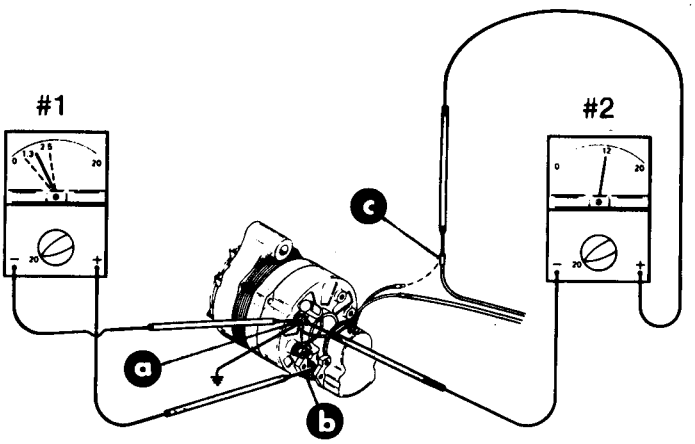
1. Connect positive voltmeter lead to alternator output terminal and negative lead to a ground terminal on alternator.
2. Shake engine wiring harness while observing voltmeter. Meter should indicate approximately battery voltage and should not vary. If no reading is obtained, or if reading varies, check alternator output circuit for loose or dirty connections or damaged wiring.



a - Output Terminal
b - Ground Terminal

Excitation Circuit

1. **TEST 1:** Remove screws which secure the regulator to the alternator.
2. Connect positive (+) voltmeter lead to regulator terminal (green wire) on alternator and negative (-) lead to ground terminal on alternator.

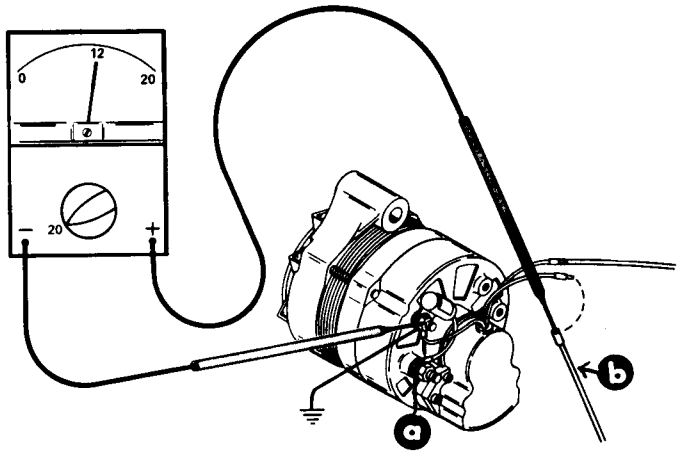


a - Ground Terminal
b - Green Wire
c - Purple Wire

3. Turn ignition switch to "on" position and note voltmeter reading. Reading should be 1.3 to 2.5 volts.
4. If no reading is obtained, an opening exists in alternator excitation lead or in excitation circuit of regulator. Unplug purple lead from regulator.
5. **TEST 2:** Connect positive voltmeter lead to purple lead and negative voltmeter lead to ground. If voltmeter now indicates approximate battery voltage, voltage regulator is defective and must be replaced. If no voltage is indicated, check excitation circuit for loose or dirty connections or damaged wiring.
6. If reading is between .75 and 1.1 volts, rotor field circuit probably is shorted or grounded. Disassemble alternator and test rotor as outlined under "Alternator Repair", following.
7. If reading is between 6.0 and 7.0 volts, rotor field circuit probably is open. Remove regulator and inspect for worn brushes or dirty slip rings. Replace brushes if less than ¹⁄₄" (6.5mm) long. If brushes and slip rings are in good condition, disassemble alternator and test rotor, as outlined following.

Sensing Circuit

1. Unplug red/purple lead from voltage regulator.
2. Connect positive voltmeter lead to red/purple lead and negative voltmeter lead to ground terminal.



a - Output (Orange)
b - Sensing (Red-Purple)

3. Voltmeter should indicate battery voltage. If battery voltage is not present, check sensing circuit (red/-purple lead) for loose or dirty connections or damaged wiring.

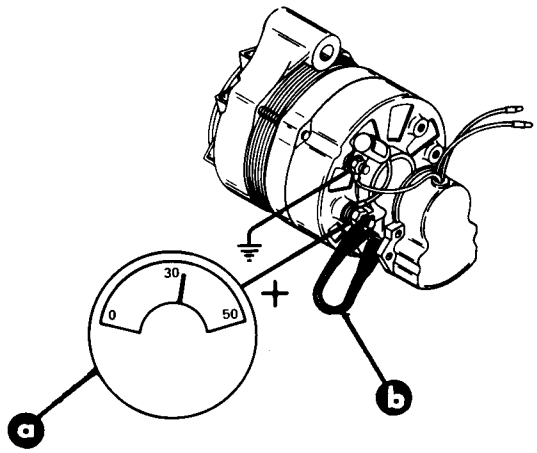
CURRENT OUTPUT

Perform this test to check if alternator is capable of producing rated current output, using a 0-50 amp DC ammeter.

⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

1. Disconnect negative (-) battery cable from battery.
2. Disconnect orange lead from alternator output terminal and connect ammeter in series between lead and output terminal. Connect positive (+) side of ammeter toward output terminal.



a - Output (Orange)
b - Jumper Lead

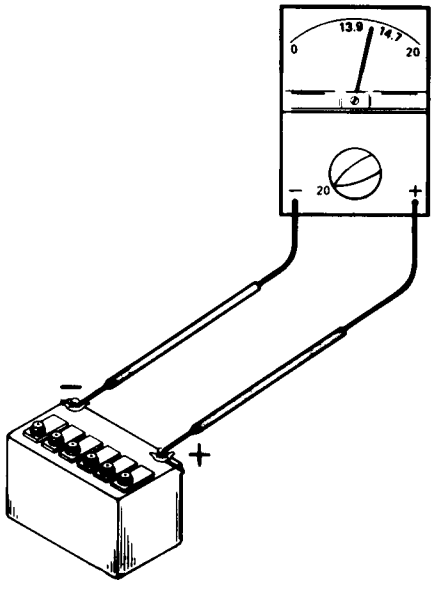
3. Reconnect negative battery cable.
4. Remove coil hi-tension lead from distributor cap tower and ground it to block. Turn on all accessories and crank engine over with starter motor for 15-20 seconds.
5. Turn off accessories and reinstall coil hi-tension lead. Start engine and adjust engine speed to 1500-2000 RPM. Quickly observe ammeter. Reading should be at least 30 amps.
6. If reading is low, stop engine and connect a jumper lead between alternator output terminal and regulator terminal. Repeat Steps 4 and 5.
7. If reading is now within specifications, diode trio is faulty, replace diode trio.
8. If reading is still low with jumper lead connected, perform "Voltage Output Test," following, to determine if fault is in regulator or alternator.

VOLTAGE OUTPUT

Perform this test to determine if voltage regulator is operating correctly, using a 0-20 volt DC voltmeter.

IMPORTANT: Battery must be fully charged (1.260 or above specific gravity) to obtain proper voltage reading in this test. If necessary, charge with a battery charger or run engine to charge battery.

1. Connect positive (+) voltmeter lead to positive battery terminal and negative (-) voltmeter lead to negative terminal.



2. Start engine and run at fast idle until engine reaches normal operating temperature. Adjust engine speed to 1500-2000 RPM and observe voltmeter for highest reading. Reading should be between 13.9 and 14.7 volts.

3. If reading is high, check for a loose or dirty regulator ground lead connection. If connection is good (and sensing circuit checks out good) voltage regulator is faulty and must be replaced. Be sure to disconnect battery cables before attempting to remove regulator.

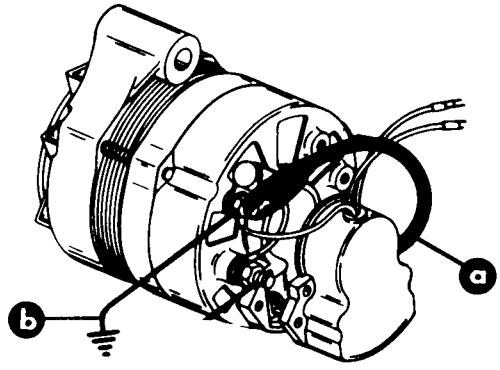
⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present to prevent the possibility of an explosion and/or a fire, should a spark occur.

⚠CAUTION

Do not allow jumper wire to contact alternator end frame, as diode trio and regulator may be damaged.

4. If reading is low, stop engine and remove regulator attaching screws. Pull regulator away from alternator end frame to gain access to field and regulator terminals. Do not disconnect regulator terminals. Connect a jumper lead from the ground stud to the brush terminal that has a tan wire attached. Restart engine and gradually increase engine speed to 1500 RPM while observing voltmeter. Do not allow voltage to exceed 16 volts.



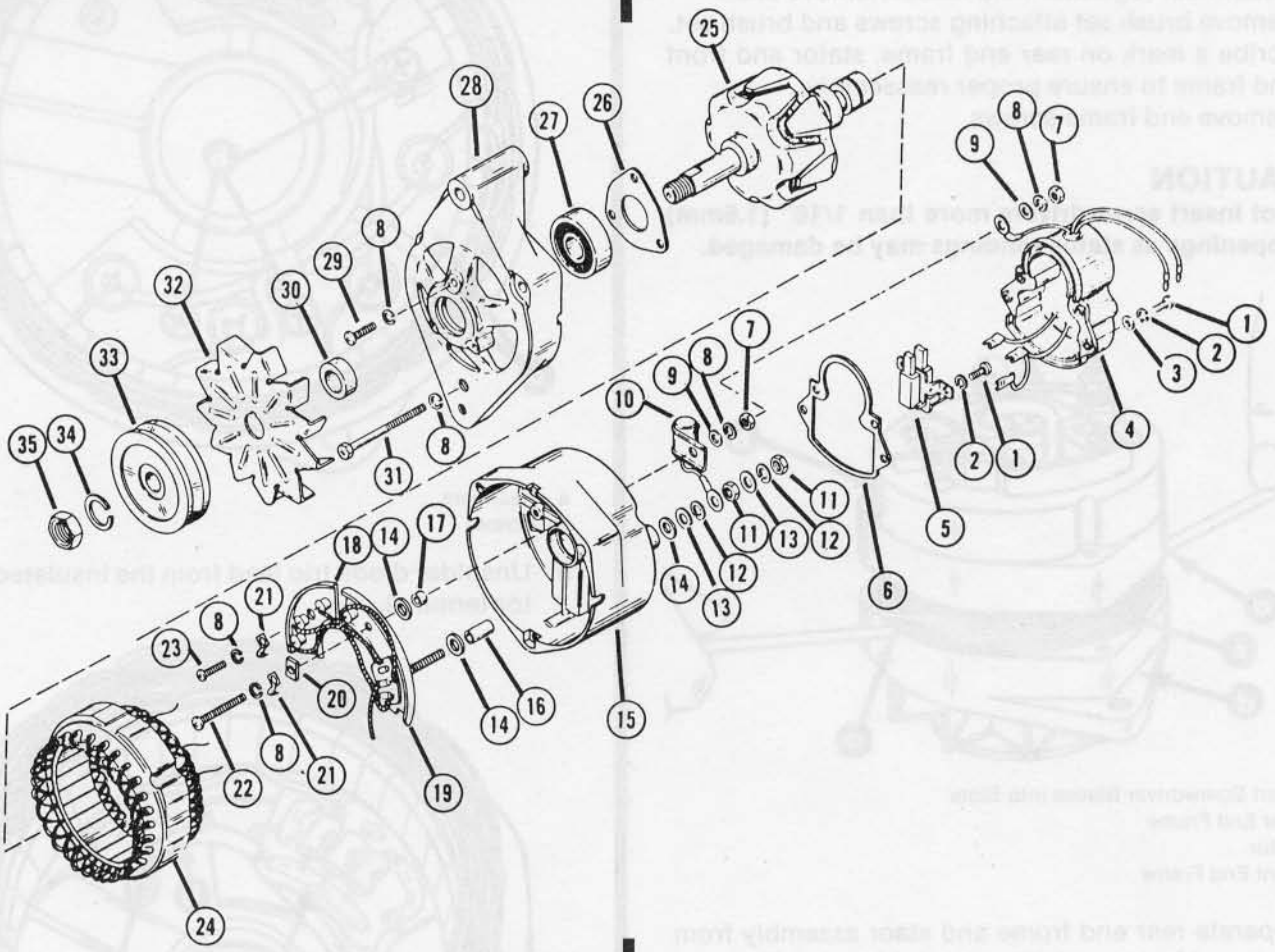
a - Jumper Lead
b - Ground Stud

5. If a voltmeter reading of 14.5 volts or above is now obtained, voltage regulator must be replaced. If voltmeter reading is below 14.5 volts, inspect brushes and slip rings. If brushes and slip rings are good, alternator is faulty internally. Disassemble alternator and test components.

Repair

REMOVAL

1. Disconnect battery cables from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternator brace to alternator attaching bolt, washer(s) and spacer (if used).
4. Loosen alternator brace to engine attaching bolt and alternator mounting bolt, then pivot alternator inward and remove alternator drive belt.
5. Remove alternator mounting bolt, washers (if used), spacer and nut and remove alternator.



1. Regulator Attaching Screw (6)
2. Lockwasher (6)
3. Flatwasher (4)
4. Regulator
5. Brush Set
6. Rubber Seal
7. Nut
8. Lockwasher (6)
9. Flatwasher (2)
10. Condenser
11. Nut
12. Lockwasher (2)
13. Flatwasher (2)
14. Insulating Washer (3)
15. Rear End Frame
16. Insulating Sleeve - Long
17. Insulating Sleeve - Short
18. Negative (-) Rectifier
19. Positive (+) Rectifier
20. Insulator - Rectangular
21. Clip (2)
22. Positive (+) Rectifier Attaching Screw (1)
23. Negative (-) Rectifier Attaching Screw (2)
24. Stator
25. Rotor
26. Front Bearing Retaining Plate
27. Front Bearing
28. Front End Frame
29. Front Bearing Retaining Plate Screw (3)
30. Spacer
31. Front End Frame Attaching Screw (3)
32. Fan
33. Pulley
34. Lockwasher
35. Nut

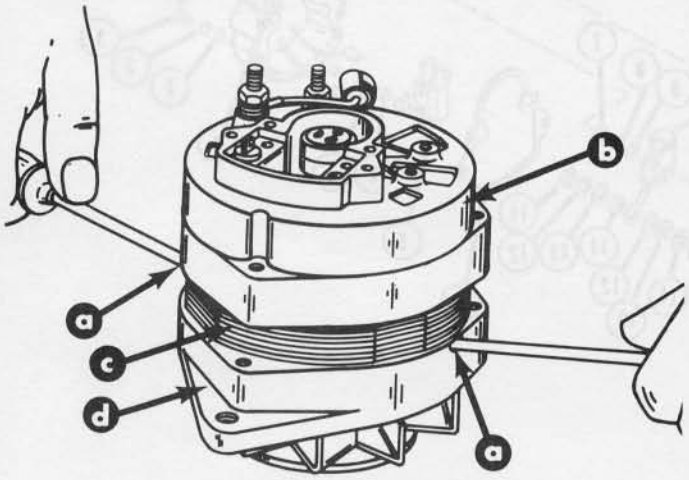
DISASSEMBLY

The following instructions are for complete disassembly and overhaul of the alternator. In many cases, however, complete disassembly of alternator is not required and, in those cases, it is necessary only to perform the operations required to repair or replace the faulty part.

1. Mount alternator in a vise.
2. Disconnect regulator leads from terminals on rear end frame. Remove regulator attaching screws, then pull regulator away from rear end frame and disconnect regulator field leads. Remove seal.
3. Remove brush set attaching screws and brush set.
4. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly.
5. Remove end frame screws.

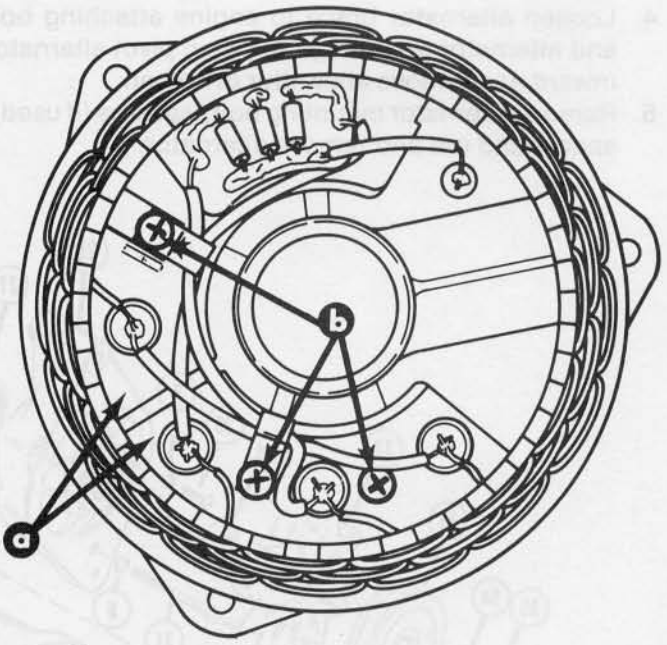
⚠CAUTION

Do not insert screwdrivers more than 1/16" (1.6mm) into openings as stator windings may be damaged.



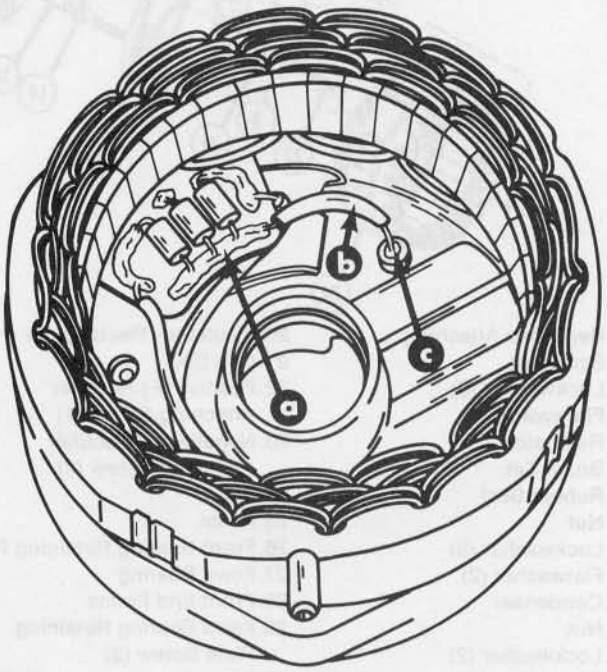
a - Insert Screwdriver Blades into Slots
b - Rear End Frame
c - Stator
d - Front End Frame

6. Separate rear end frome and staor assembly from front end frame and rotor assembly using 2 screwdrivers as shown. Use the two slots shown to initially separate units.
7. Place rear end frame and stator assembly on bench with stator downward. Remove nuts, washers, insulators and condenser from output and ground studs.
8. Turn end frame over (stator upward) and remove the three screws which secure rectifiers to end frame.



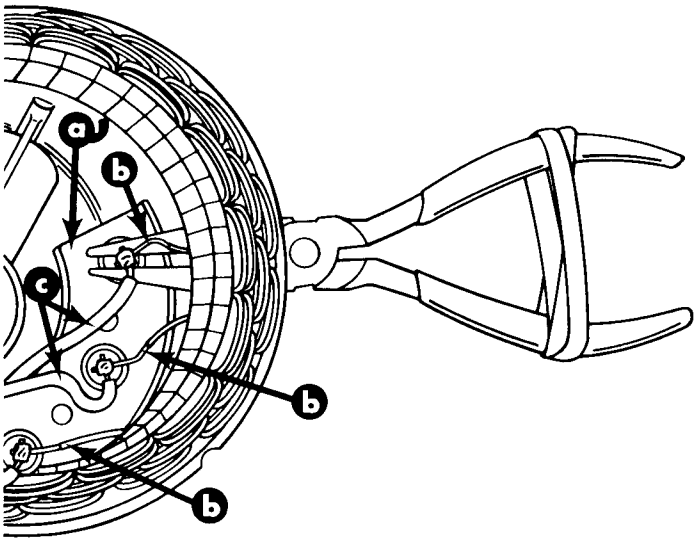
a - Rectifiers
b - Screws

9. Unsolder diode trio lead from the insulated regulator terminal.



a - Diode Trio
b - Diode Trio Lead
c - Insulated Regulator Terminal

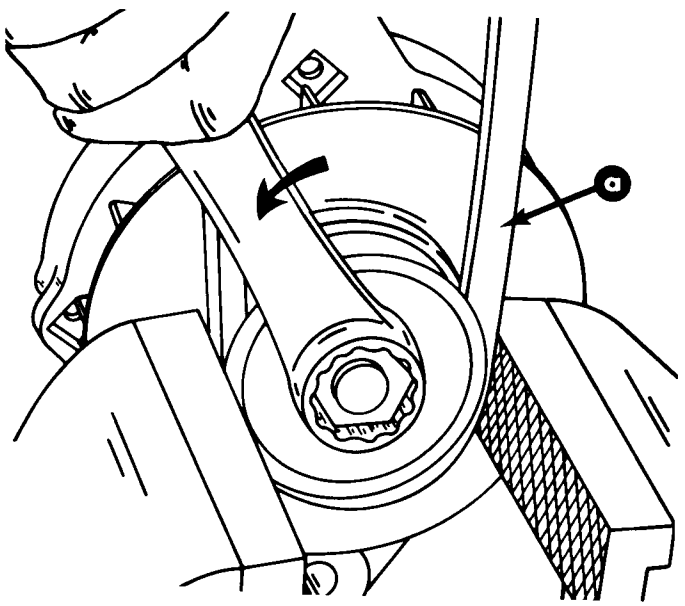
10. Unsolder the three stator leads along with the three coated leads from the negative (-) rectifier heat sink. Place a needle nose pliers on diode terminal between solder joint and diode body to help prevent heat damage to diodes. Unsolder joints as quickly as possible and allow diode terminal to cool before removing pliers.



a - Negative (-) Heat Sink
b - Stator Leads (3)
c - Coated Leads (3) (2 Shown)

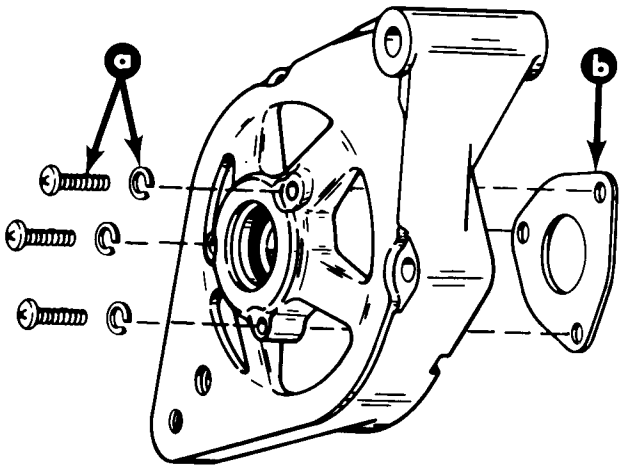
IMPORTANT: Do not clamp vise on rotor pole pieces when removing pulley nut, as pole pieces may be distorted.

11. Remove pulley nut as shown (using an oversize V-belt or protective jaws to protect pulley). Remove lockwasher, pulley, and fan.



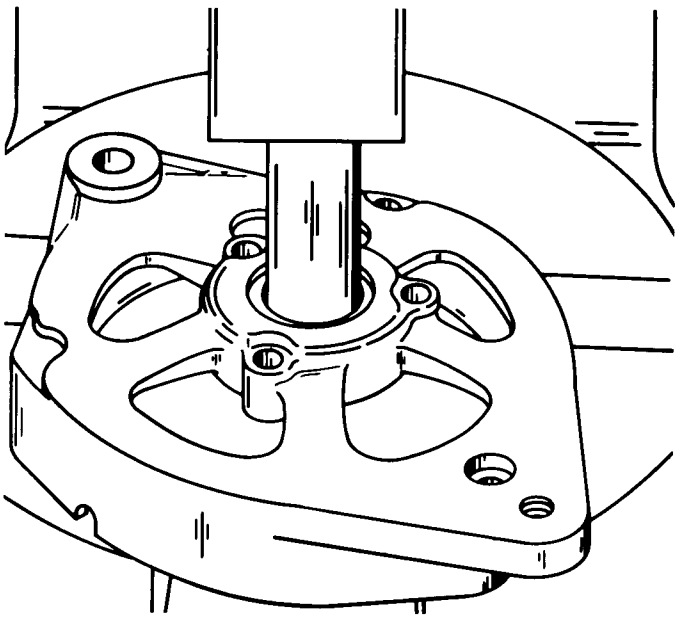
a - Oversize V-Belt

12. Remove the screws and lockwashers which secure the front bearing retaining plate.



a - Screws and Lockwashers
b - Front Bearing Retaining Plate

13. Remove front bearing from front end frame using an arbor press. (Discard bearing).



14. If rotor slip rings or rear bearing require replacement, entire rotor must be replaced. Parts cannot be purchased separately.

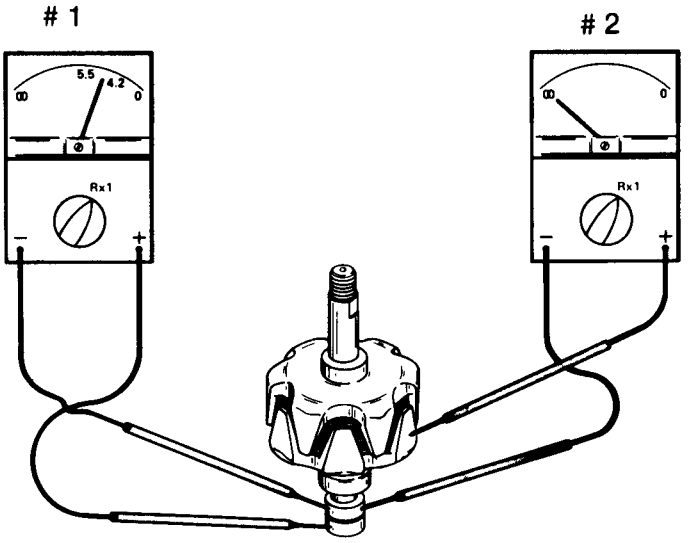
INSPECTION and CLEANING

1. Clean all parts with a clean, soft cloth. Do not use solvent, or electrical components may be damaged.
2. Inspect the following,
   a. **Brush set** - inspect for cracked porcelain casing, damaged brush leads, poor brush springs or worn brushes. Replace brush set if brushes are less than ¼" (6.5mm) long.
   b. **Rotor** - inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of for bearing turning on shaft).
   c. **Rotor slip rings** - clean slip rings with 400 grain (or finer) polishing cloth while spinning rotor in a lathe. Blow off dust with compressed air. Inspect slip rings grooves, pits, flat spots or out-of-round [.002" (.05mm) maximum] and replace, if required.
   d. **Rotor shaft bearings** - inspect for damaged seals, lack of lubrication, discoloration (from overheating) or excessive side or end play. Hold inner race of bearings while turning outer race. Bearing should turn freely without binding or evidence of rough spots.
   e. **Stator** - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.
   f. **Regulator** - inspect leads for damaged insulation.
   g. **Front and rear end frames** - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). End frame(s) must be replaced, if bearing has spun. Also, inspect bearing retainer recess in front end frame for damage.
   h. **Fan** - inspect for cracked or bent fins, broken welds (bi-directional fan only) or worn mounting hole (from fan spinning on shaft).
   i. **Pulley** - inspect pulley mounting bore and for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, or corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush or replace pulley. Drive surfaces must be true and smooth, or drive belt wear will be greatly accelerated.
   j. **Alternator** - if alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, because of centrifugal force. Replace rotor, if all other electrical components test good.

COMPONENT TESTING

Rotor

1. **(Test 1),** rotor field circuit for opens, shorts or high resistance. Use an ohmmeter (set on Rx1 scale), as follows:



   a. Connect one ohmmeter lead to each slip ring.
   b. Ohmmeter reading should be 4.2 to 5.5 ohms with rotor at room termperature 70°-80° F (21°-26° C).
   c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, or if reading is still high or infinite, replace complete rotor assembly.
   d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder filed winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, or if reading is still low, slip rings and rotor field windings are shorted, and complete rotor assembly must be replaced.

2. **(TEST 2),** rotor field circuit for grounds. Use an ohmmeter (set on Rx1 scale) as follows:

   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.

   b. Meter should indicate no continuity, meter should not move.

   c. If continuity does exist, rotor field circuit is grounded. Inspect slip ring terminals to be sure that they are not bent and touching rotor shaft. Also be sure that excess solder is not grounding terminals to rotor shaft. If cause for ground cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter between one of the leads and rotor shaft or pole pieces. If continuity still exists, replace rotor assembly. If continuity is eliminated, replace slip rings.

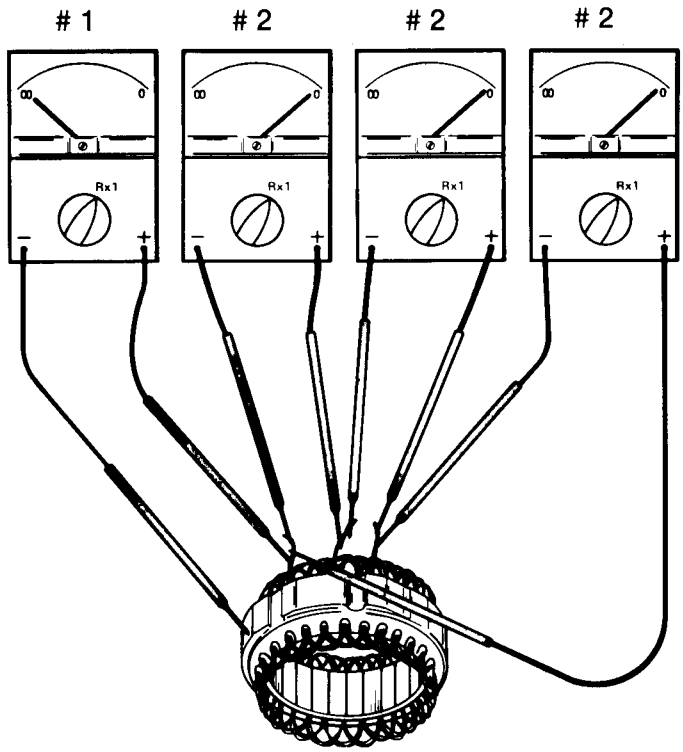
Stator

IMPORTANT: Stator leads must be disconnected from rectifier diodes and diode trio for this test.

1. **(TEST 1),** stator for grounds using an ohmmeter (set on Rx1 scale) as follows:

   a. Connect one lead of ohmmeter to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.

   Meter should indicate no continuity (meter should not move). If continuity does exist, stator must be replaced.



2. **(TEST 2),** for opens in stator using an ohmmeter (set on Rx1 scale) as follows:

   a. Connect ohmmeter or test lamp between each pair of stator windings (3 different ways). Continuity should be present in all 3 cases (meter should move. If it does not, one or more of the windings are open and stator must be replaced.

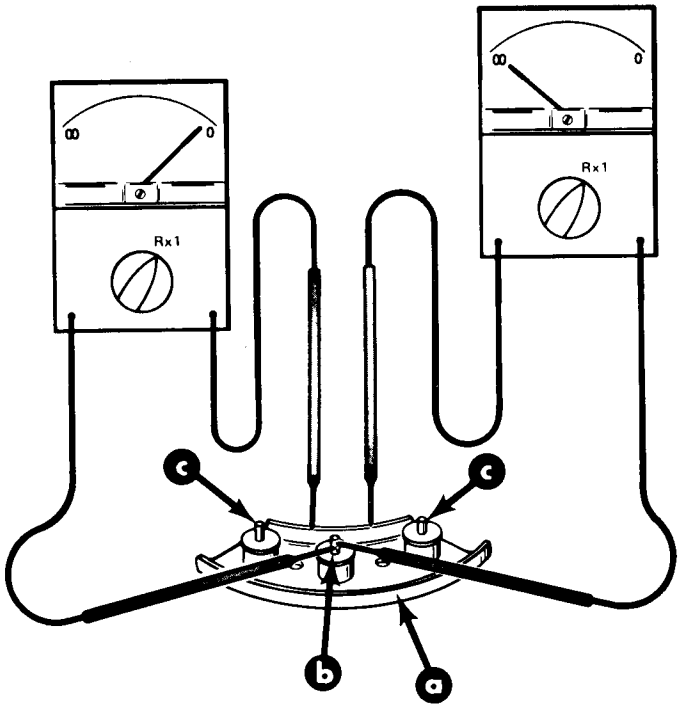
3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discolorations, as this usually is a sure sign of a short.

Negative (-) Rectifier Diodes

IMPORTANT: Rectifier diodes must be disconnected from stator for this test.

IMPORTANT: Do not use a test instrument with more than a 12-volt source as rectifier diodes may be damaged.

1. Connect one lead of an ohmmeter (set on Rx1 scale) to negative (-) rectifier diode heat sink and the other lead to one of the rectifier diode terminals. Note the reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
4. Repeat Steps 1-thru-3 for 2 other rectifier diodes in heat sink.
5. Replace complete rectifier set, if any one of the diodes is shorted or open.

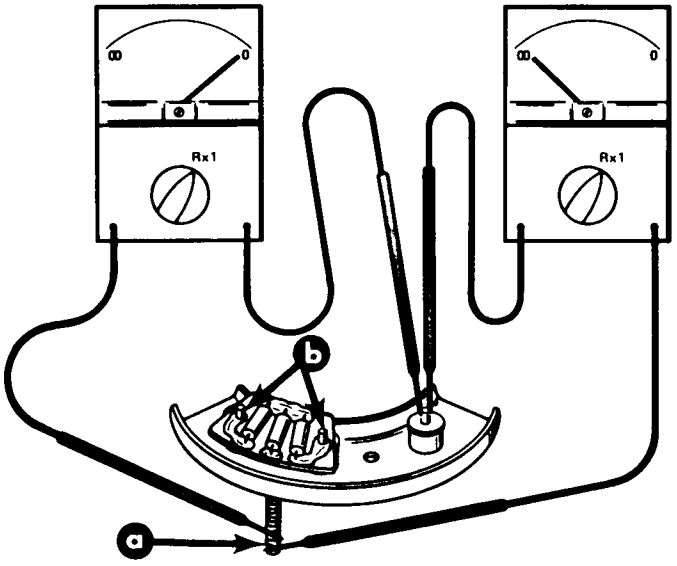


a - Heat Sink
b - Diode Terminal
c - Test These 2 Diodes in Same Manner

Positive (+) Rectifier Diodes and Diode Trio

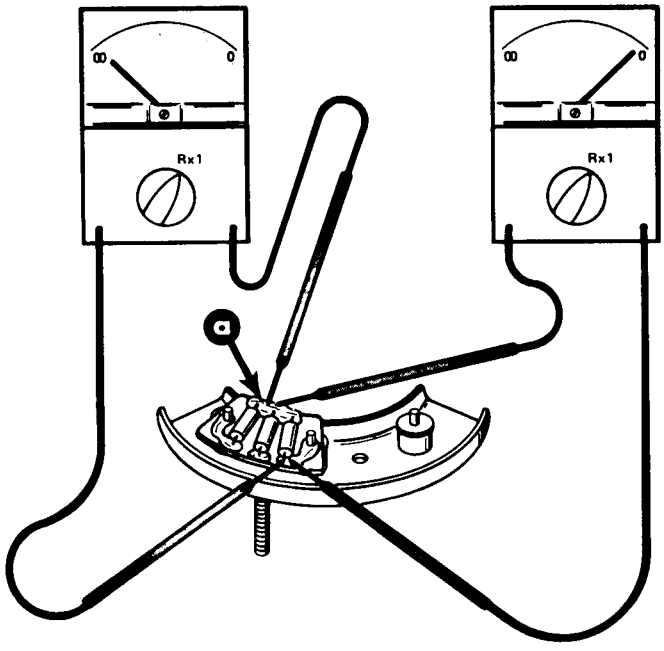
IMPORTANT: Do not use a test instrument with more than a 12-volt source (in the following test), as rectifier diodes may be damaged.

1. Connect one lead of an ohmmeter (set on Rx1 scale) to ⅜" stud on positive (+) rectifier heat sink and the other lead to one of the rectifier diode terminals. (Note: Two of the diode terminals come up thru the diode trio circuit board.) Note the meter reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when conected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
4. Repeat Steps 1-thru-3 for 2 other rectifier diodes in heat sink.
5. Replace complete rectifier set, if any one of the diodes is shorted or open.



a - Stud
b - Repeat Test between These Terminals and Stud

6. Connect one lead of an ohmmeter (set on Rx1 scale) to the common side on the diode trio circuit board and the other lead to the other side of one of the three trio diodes. Note the reading.
7. Reverse leads and again note reading.
8. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode trio is open. If both readings are low, diode trio is shorted.
9. Repeat Steps 6-thru-8 for the other 2 diodes.
10. Replace positive (+) rectifier and diode trio assembly if any one of the diodes is shorted or open.



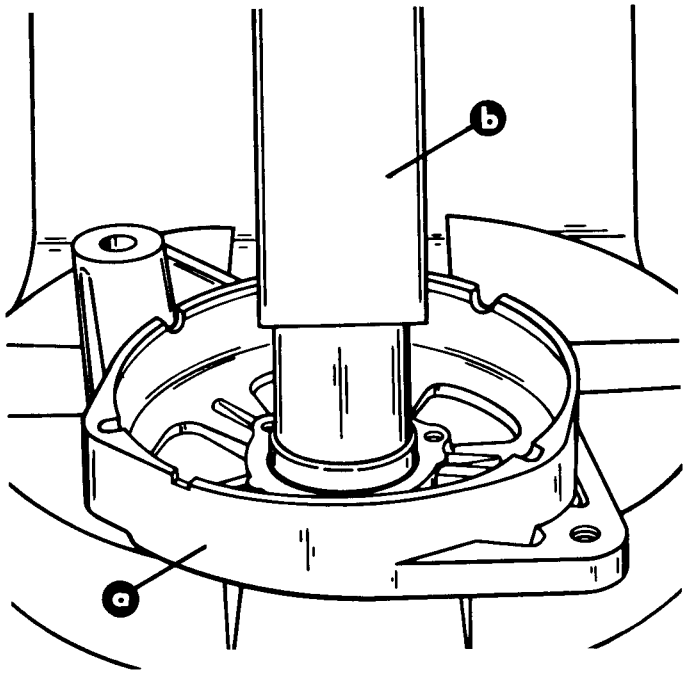
a - Common Side of Diode Trio Circuit Board

Condenser

1. Using Magneto Analyzer (91-76032) and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd)
   b. Condenser Short or Leakage Test
   c. Condenser Series Resistance Test
2. Replace condenser, if test results are not within specifications.

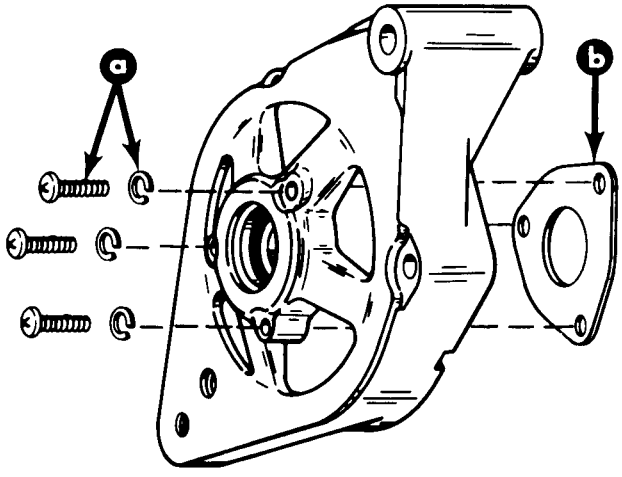
REASSEMBLY

1. Install new front bearing into front end frame bearing bore using an arbor press.



a - End Frame
b - Arbor Press

2. Install front bearing retaining plate, screws and lockwashers.

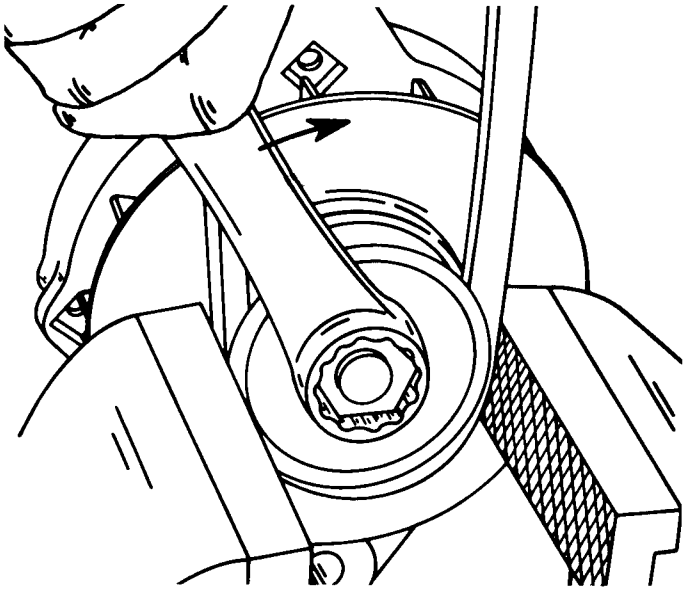


a - Screws and Lockwashers
b - Front Bearing Retaining Plate

3. Slide front end frame over rotor.

IMPORTANT: Do not clamp vise on rotor pole pieces when tightening pulley nut (in next step), or pole pieces may be distorted.

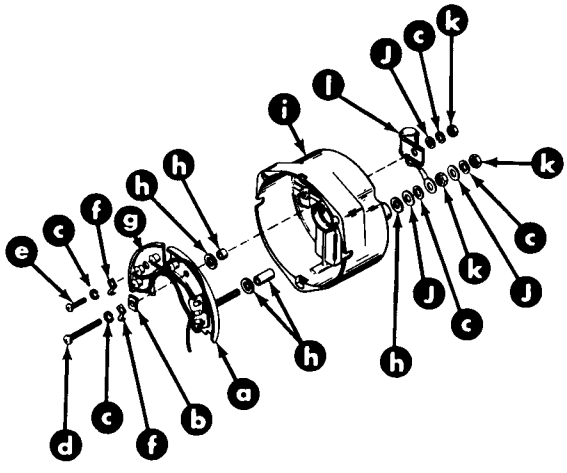
4. Install spacer, fan, pulley, lockwasher and nut on shaft. Clamp pulley in a vise, using protective jaws or an old oversize V-belt to protect pulley and torque nut to specifications.



⚠CAUTION

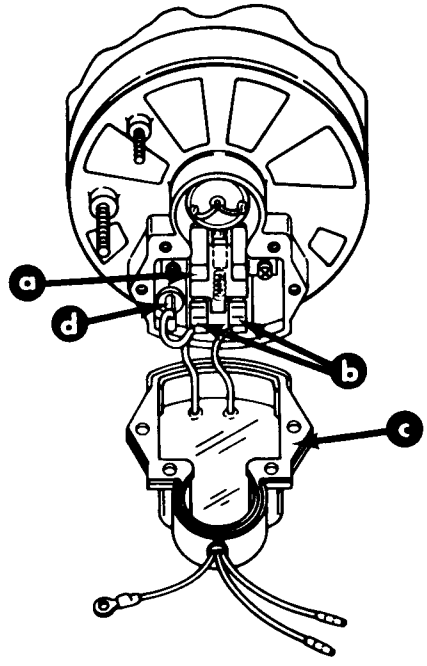
The insulating washers must be installed as shown or damage to the alternator will result.

5. Install positive (+) and negative (-) rectifier heat sinks, as shown.
6. Position rear end frame and stator assembly over front end frame and rotor assembly and align scribe marks on each (scribed during assembly). Hand-press end frames together, then install screws. Torque screws evenly to specifications.



a - Positive (+) Rectifier Heat Sink
b - Rectangular Insulator
c - Lockwasher
d - Screw - 1-1/2" (38mm) Long
e - Screw - 1/2" (13mm) Long; 2 Required
f - Clip
g - Negative (-) Rectifier Heat Sink
h - Insulator
i - Rear End Frame
j - Flat Washer
k - Nut
l - Condenser

7. Place brush set in end frame and secure with mounting screws. Be sure to use outer-most mounting holes. Torque screws to specifications.
8. Position seal on regulator mounting surface. Connect regulator field leads and regulator lead to brush and regulator terminals, then mount regulator. Torque screws to specifications. Connect ground terminal and secure with lockwashers and nuts. Torque nuts to specifications.



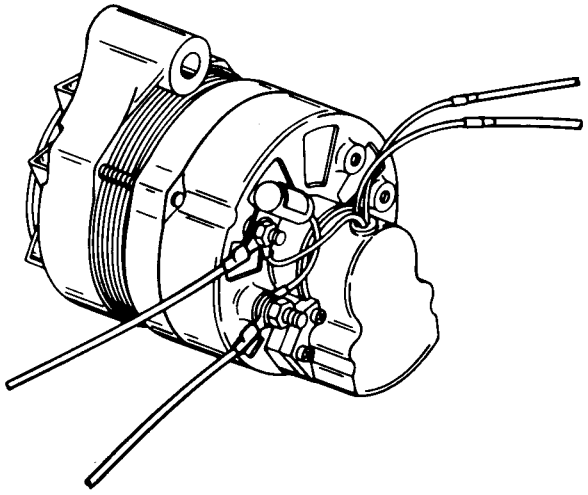
a - Brush Set (Use Outer Mounting Holes)
b - Be Sure to Connect Field Leads as Shown
c - Regulator Seal
d - Insulated Regulator Terminal

⚠CAUTION

Regulator field leads must be connected as shown, or leads may be damaged by rotor slip rings during operation.

INSTALLATION

1. Position alternator in mounting bracket and install bolt, washers (if used), spacer and nut. Place washers (if used), on each side of spacer. Do not tighten securely at this time.
2. Fasten alternator brace to alternator with bolt, washers and spacer (if used). Do not tighten at this time.
3. Position alternator drive belt on pulleys and adjust tension per specifications.

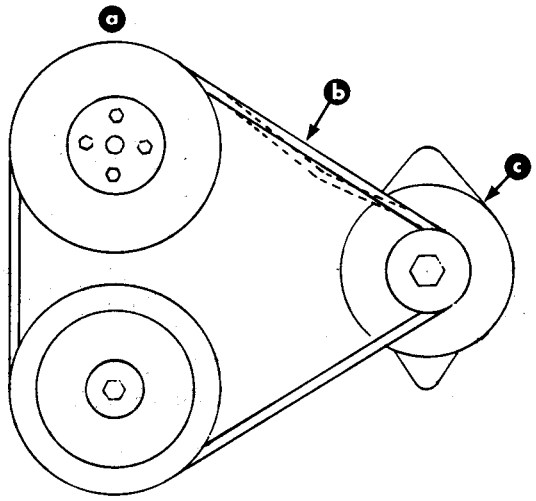


4. Tighten all fasteners securely.
5. Reconnect wiring to alternator and battery cables to battery.

Drive Belt Replacement and Adjustment

IMPORTANT: When adjusting drive belt tension (in next step), do not apply pressure to alternator rear end frame, as alternator may be damaged.

1. Check belt tension by depressing belt with thumb at midway point. Belt should depress 1" (13mm).



a - Circulating Pump Pulley
b - Check Point
c - Alternator

2. If adjustment or replacement is necessary, loosen alternator brace attaching bolts and alternator mounting bolt.
3. Pivot alternator inward to replace drive belt.
4. Pivot alternator outward, to obtain correct belt tension. Apply pressure to alternator front end frame only. Set new belts at high reading.
5. Retighten alternator brace attaching bolts and alternator mounting bolt securely.
6. Recheck drive belt tension.

MOTOROLA ALTERNATOR

SPECIFICATIONS

Excitation Circuit	1.3 to 2.5 Volts
Current Output	50 Amp. Min.
Voltage Output	13.9 to 14.7 Volts
Condenser Capacity	.5 MFD

TORQUE SPECIFICATIONS

FASTENER LOCATION	LBS. FT. (N.m)	LBS. IN. (N.m)
End Frame Screws		50-60 (6-7)
Brush Set Screws		16-20 (1-2)
Regulator Mounting Screws		40-45 (4-5)
Regulator Leads		20-30 (2-3)
Ground Terminal Nut		20-30 (2-3)
Pulley Nut	35-50 (48-68)	
Alternator Brace to Alternator		192 (28)
Alternator Brace to Block	30 (41)	
Alternator to Mounting Bracket	35 (48)	
Alternator Mounting Bracket	30 (41)	
V-Belt Tension (Note 1)	Depress 1/2 In.	

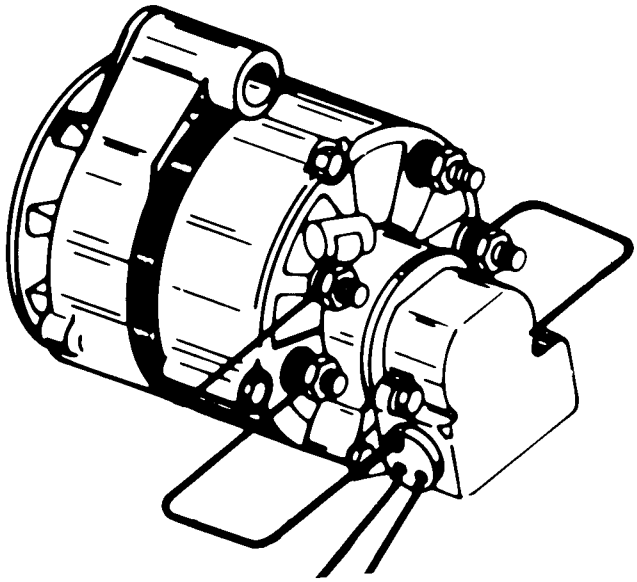
NOTE 1: Depress Belt with Thumb at Midway Point between Circulating Pump Pulley and Alternator.

SPECIAL TOOLS

91-76032	Magneto Analyzer
91-93572	Volt/Ohm Meter

Identification

Motorola



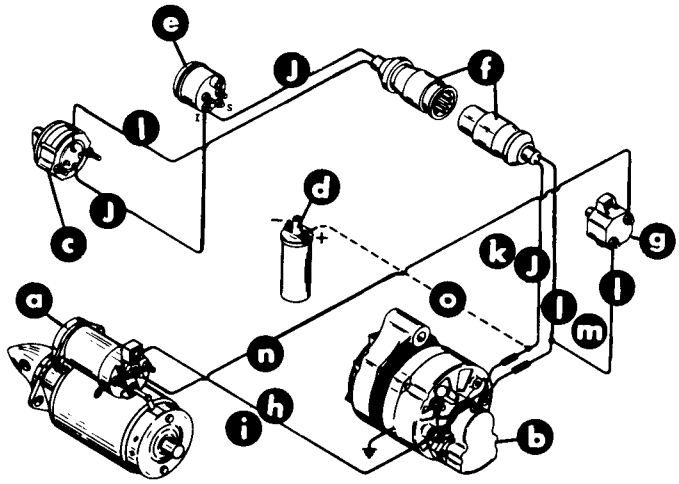
Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

System Components

The alternator system, used on engines with Mando Alternators consists of the alternator, battery, the ignition switch and the wiring which connects these components.



a - Starter
b - Alternator
c - Ignition Switch
d - Coil
e - Battery Meter
f - Harness Plug
g - Circuit Breaker
h - Orange
ı - Output Lead
j - Purple
k - Excitation Lead
l - Red/Purple
m - Sensing Lead
n - Red
o - Resistance Wire

Precautions

The following precautions must be observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. Do not attempt to polarize the alternator.
2. Do not short across or ground any of the terminals on the alternator, except as specifically instructed.
3. Never disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. Never disconnect regulator lead from alternator regulator terminal when the alternator is being driven by engine.
5. Always remove negative (-) battery cable from battery before working on alternator system.
6. When installing battery, be sure to connect the negative (-) (grounded) battery cable to negative (-) battery terminal and the positive (+) battery cable to positive (+) battery terminal.
7. If a charger or booster battery is to be used. Be sure to connect it in parallel with existing battery (positive to positive; negative to negative).

Diagnosis

The alternator employs a rotor, which is supported in 2 end frames by ball bearings, and is driven (via a pulley) at approximately twice engine speed. The rotor contains a field winding that is enclosed between 2 multiple-finger pole pieces. The ends of the field winding are connected to 2 brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between the 2 end frames. It consists of 3 windings wound 120° electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains 6 diodes which are arranged so that current flows from ground, thru the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator also is not required, as the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifier and stator. A capacitor also is utilized to protect the rectifier system from high voltages and to suppress radio noise.

Diagnosis On Engine

Before proceeding with the tests, perform the following checks to eliminate possible problem areas. Also observe "Precautions," immediately preceding, to prevent damage to alternator system.

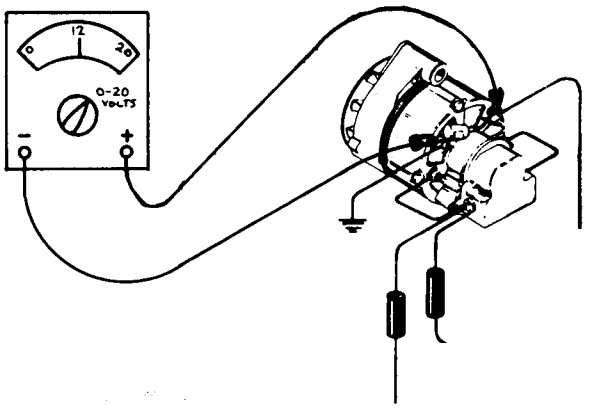
1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery. Battery must be at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt and replace if necessary. Also, check tension and adjust if necessary, as outlined under "Drive Belt Replacement and Adjustment."

ALTERNATOR SYSTEM CIRCUITRY TEST

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

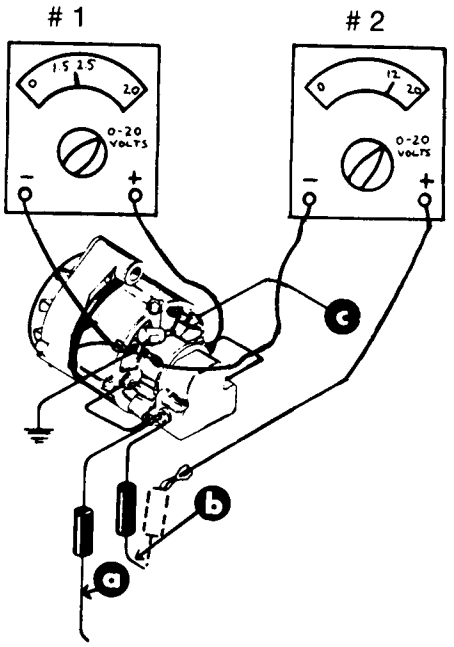
Output Circuit

1. Connect positive voltmeter lead to alternator output terminal and negative lead to a ground terminal on alternator.
2. Shake engine wiring harness while observing voltmeter. Meter should indicate approximately battery voltage and should not vary. If no reading is obtained, or if reading varies, check alternator output circuit for loose or dirty connections or damaged wiring.



Excitation Circuit

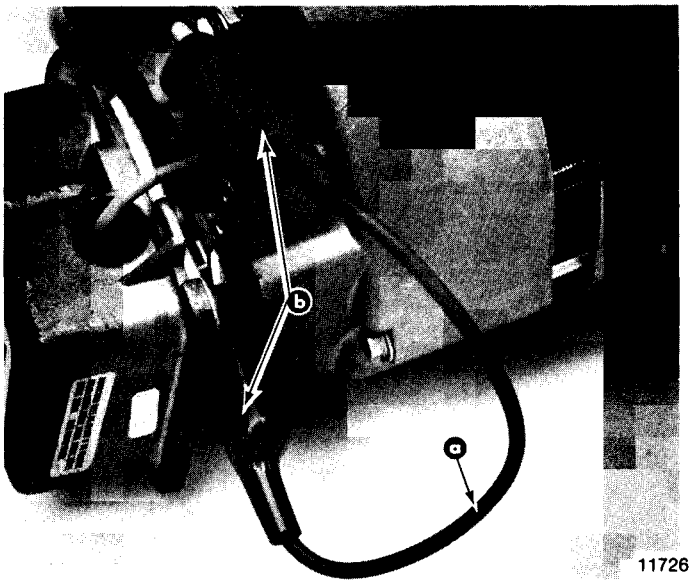
1. **TEST 1:** Connect positive (+) voltmeter lead to regulator terminal on alternator and negative (-) lead to a ground terminal on alternator.
2. Turn ignition switch to "On" position and note voltmeter reading. Reading should be 1.5 to 2.5 volts.



a - Sensing (Red-Purple)
b - Excitation (White or Purple)
c - Output (Orange or Red-White)

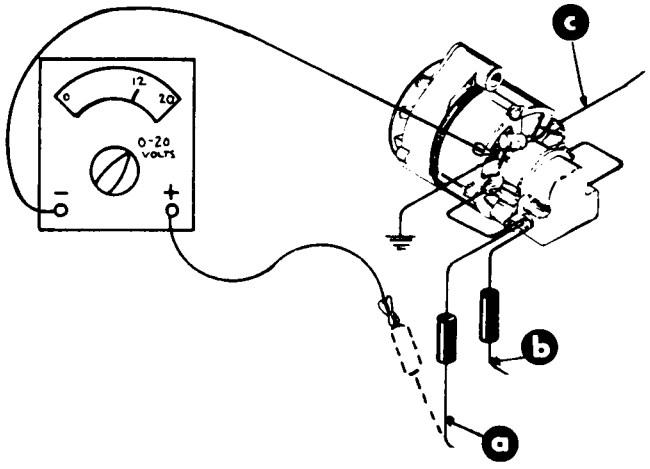
3. If no reading is obtained, an opening exists in alternator excitation lead or in excitation circuit of regulator. Unplug white or purple lead from regulator.
4. **TEST 2:** Connect positive voltmeter lead to white or purple lead and negative voltmeter lead to ground. If voltmeter now indicates approximate battery voltage, voltage regulator is defective and must be replaced. If no voltage is indicated, check excitation circuit for loose or dirty connections or damaged wiring.
5. If reading is between .75 and 1.1 volts, rotor field circuit probably is shorted or grounded. Disassemble alternator and test rotor as outlined following.
6. If reading is between 6.0 and 7.0 volts, rotor field circuit probably is open. Remove regulator and inspect for worn brushes or dirty slip rings. Replace brushes if less than ½" (6.5mm) long. If brushes and slip rings are in good condition, disassemble alternator and test rotor, as outlined under "Alternator Repair."

7. If reading is between 8.5 and 10.0 volts, an open probably exists in load circuit of regulator. To be certain that this is the problem, remove screws which secure the regulator to the alternator. Connect a jumper wire between regulator terminal and field terminal. Do not allow jumper lead to touch alternator housing. Repeat test. If jumper wire provides correct voltmeter reading (1.5 to 2.5 volts), voltage regulator is faulty and must be replaced.



Sensing Circuit

1. Unplug red/purple lead from voltage regulator.
2. Connect positive voltmeter lead to red/purple lead and negative voltmeter lead to ground terminal.
3. Voltmeter should indicate battery voltage. If battery voltage is not present, check sensing circuit (red/-purple lead) for loose or dirty connections or damaged wiring.



a - Sensing (Red-Purple)
b - Excitation (Purple)
c - Output (Orange)

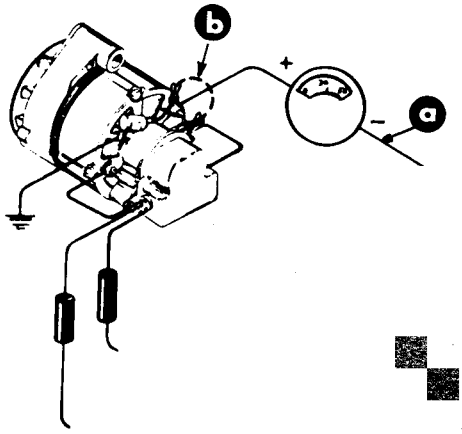
CURRENT OUTPUT

Perform this test to check if alternator is capable of producing rated current output, using a 0-50 amp DC ammeter.

⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present to prevent the possibility of an explosion and/or a fire, should a spark occur.

1. Disconnect negative (-) battery cable from battery.
2. Disconnect orange lead from alternator output terminal and connect ammeter in series between lead and output terminal. Connect positive (+) side of ammeter toward output terminal.



a - Orange Wire and Ammeter
b - Jumper Wire

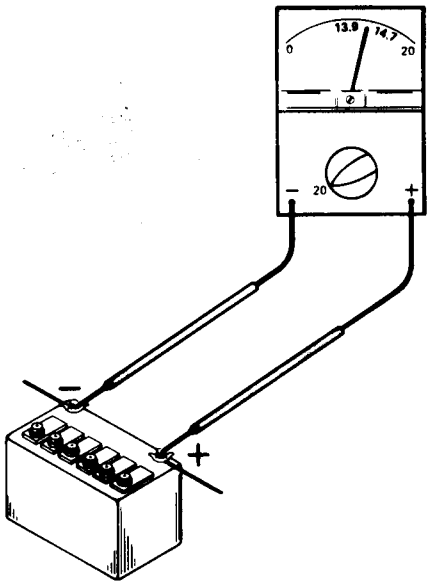
3. Reconnect negative battery cable.
4. Remove coil hi-tension lead from distributor cap tower and ground it to block. Turn on all accessories and crank engine over with starter motor for 15-20 seconds.
5. Turn off accessories and reinstall coil hi-tension lead. Start engine and adjust engine speed to 1500-2000 RPM. Quickly observe ammeter. Reading should be at least 30 amps.
6. If reading is low, stop engine and connect a jumper wire between alternator output terminal and regulator terminal. Repeat Steps 4 and 5.
7. If reading is now within specifications, diode trio is faulty. Disassemble alternator and replace diode trio, as explained, following.
8. If reading is still low with jumper wire connected, perform "Voltage Output Test," following, to determine if fault is in regulator or alternator.

VOLTAGE OUTPUT

Perform this test to determine if voltage regulator is operating correctly, using a 0-20 volt DC voltmeter.

IMPORTANT: Battery must be fully charged (1.260 or above specific gravity) to obtain proper voltage reading in this test. If necessary, charge battery with a battery charger or allow engine to run a sufficient length of time to fully charge battery before taking reading.

1. Connect positive (+) voltmeter lead to positive battery terminal and negative (-) voltmeter lead to negative terminal.



2. Start engine and run at fast idle until engine reaches normal operating temperature. Adjust engine speed to 1500-2000 RPM and observe voltmeter for highest reading. Reading should be between 13.9 and 14.7 volts.
3. If reading is high, check for a loose or dirty regulator ground lead connection. If connection is good (and sensing circuit checks out good) voltage regulator is faulty and must be replaced. Be sure to disconnect battery cables before attempting to remove regulator.

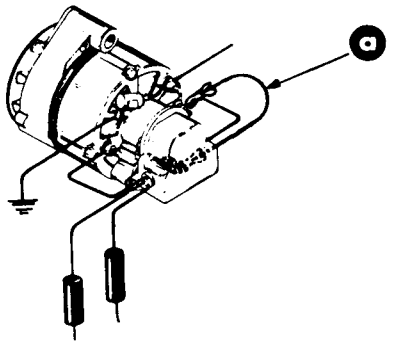
⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present to prevent the possibility of an explosion and/or a fire, should a spark occur.

⚠CAUTION

Do not allow jumper wire to contact alternator end frame, as diode trio and regulator may be damaged.

4. If reading is low, stop engine and remove regulator attaching screws. Pull regulator away from alternator end frame to gain access to field and regulator terminals. Do not disconnect regulator terminals. Connect a jumper lead from the ground stud to the brush terminal that has a tan wire attached. Restart engine and gradually increase engine speed to 1500 RPM while observing voltmeter. Do not allow voltage to exceed 16 volts.



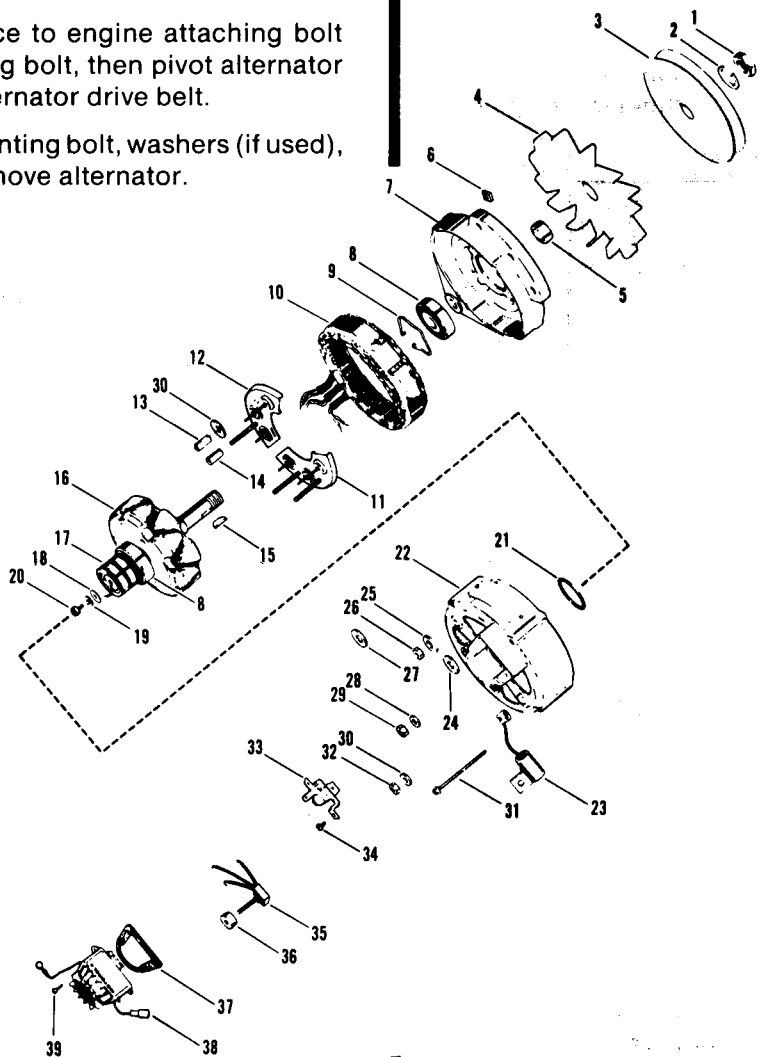
a - Jumper Lead

5. If a voltmeter reading of 14.5 volts or above is now obtained, voltage regulator must be replaced. If voltmeter reading is below 14.5 volts, inspect brushes and slip rings for wear, dirt or damage. If brushes and slip rings are good, alternator is faulty internally. Disassemble and test components.

REPAIR

REMOVAL

1. Disconnect battery cables from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternator brace to alternator attaching bolt, washer(s) and spacer (if used).
4. Loosen alternator brace to engine attaching bolt and alternator mounting bolt, then pivot alternator inward and remove alternator drive belt.
5. Remove alternator mounting bolt, washers (if used), spacer and nut and remove alternator.



- ALTERNATOR ASSEMBLY (55 Amp)

1. NUT
2. LOCKWASHER
3. PULLEY
4. FAN
5. SPACER
6. NUT
7. COVER ASSEMBLY
8. BALL BEARING
9. RETAINER
10. STATOR ASSEMBLY
11. DIODE RECTIFIER, negative
12. HEAT SINK, positive
13. SLEEVE, insulator
14. SLEEVE, insulator
15. KEY
16. ROTOR ASSEMBLY
17. SLIP RING
18. WASHER
19. LOCKWASHER
20. SCREW
21. RETAINER
22. COVER ASSEMBLY
23. CONDENSOR
24. WASHER
25. WASHER
26. NUT
27. WASHER
28. LOCKWASHER
29. NUT
30. WASHER
31. THRU BOLT
32. NUT
33. BRUSH HOLDER ASSEMBLY
34. SCREW
35. DIODE TRIO
36. SPACER
37. GASKET
38. VOLTAGE REGULATOR
39. SCREW

DISASSEMBLY

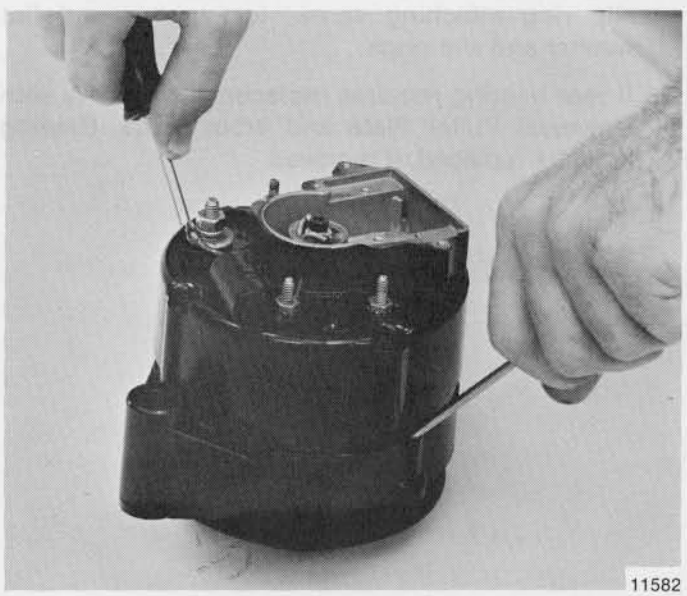
The following instructions are for complete disassembly and overhaul of the alternator. In many cases, however, complete disassembly is not required and, in those cases, it is necessary only to perform the operations required to repair or replace the faulty part.

1. Mount alternator in a vise.
2. Disconnect regulator leads from terminals on rear end frame. Remove regulator attaching screws, then pull regulator away from rear end frame and disconnect regulator field leads. Remove seal.
3. Remove brush set attaching screws and brush set.
4. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly.
5. Remove end frame screws.

⚠CAUTION

Do not insert screwdrivers more than 1/16" (1.5mm) into openings as stator windings may be damaged.

6. Separate rear end frame and stator assembly from front end frame and rotor assembly using 2 screwdrivers, in slots as shown.



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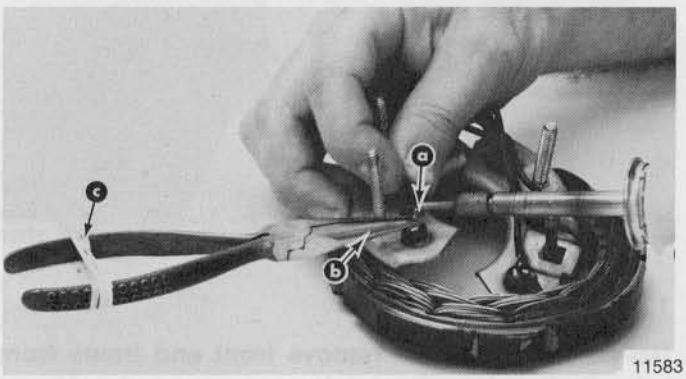
7. Remove (and discard) bearing retaining ring from rear end frame.
8. Place rear end frame and stator assembly on the bench, stator downward. Remove nuts, washers, insulators and condensor from rectifier mounting studs and lift rear end frame from studs. Remove insulating sleeves and washers from rectifier studs.
9. Unsolder stator and diode trio leads from rectifier diode terminals. Place a needle-nose pliers on diode terminal between solder joint and diode body (as shown) to help prevent heat damage to diodes. Unsolder joints as quickly as possible and allow diode terminal to cool before removing pliers.



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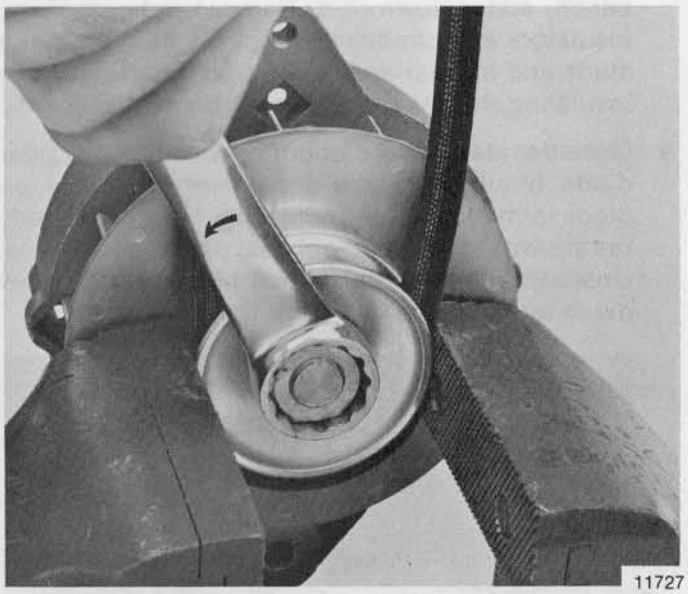
10. Remove diode trio from positive rectifier heat sink.

NOTE: With alternator disassembled to this point, stator, rectifier diodes, diode trio and rotor may be tested, as explained under "Components Testing," following.

IMPORTANT: Do not clamp vise on rotor pole pieces when removing pulley nut, as pole pieces may be distorted.

11. Remove nut, lockwasher, pulley and fan (using an old oversize V-belt or protective jaws to protect pulley).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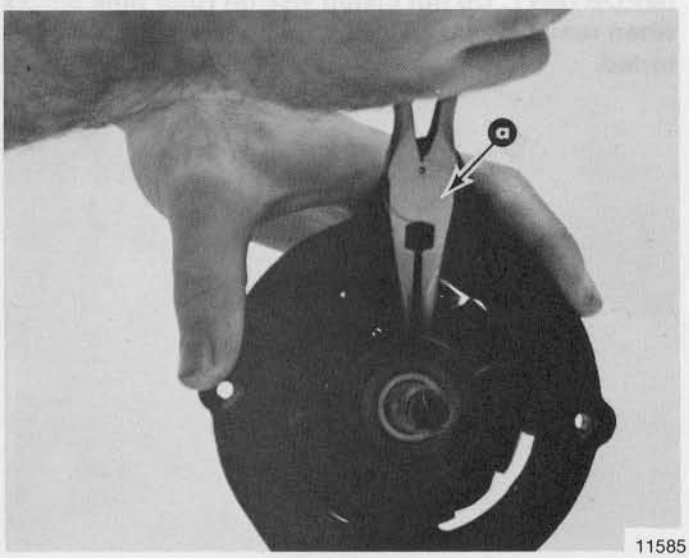
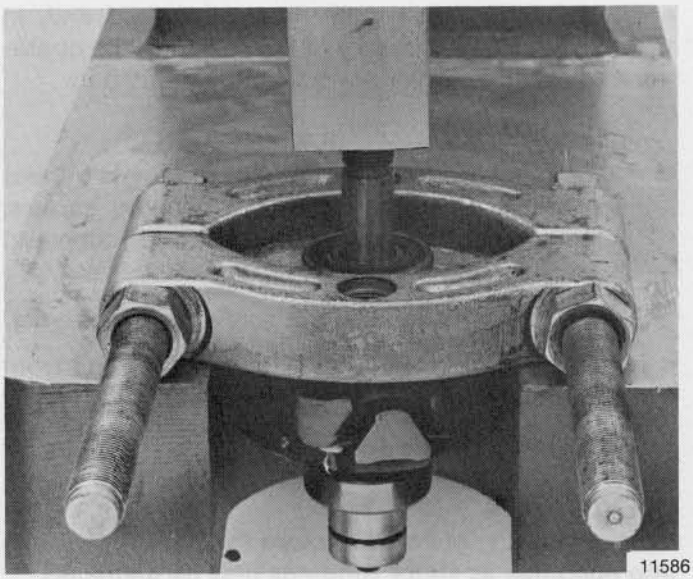
12. Remove key and spacer.

IMPORTANT: Do not remove front end frame from rotor shaft, unless absolutely necessary, as front bearing must be replaced, if it is removed.

13. Compress ears of front bearing retainer and lift retainer free of recess in front end frame. Tap pulley end of rotor shaft with a rawhide mallet to remove rotor and front bearing assembly.


11585

14. Remove front bearing from shaft with Universal Puller Plate 91-37241 or equivalent and an arbor press, as shown. (Discard bearing).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15. If rotor slip rings or rear bearing require replacement, unsolder rotor field winding leads from slip ring terminals and unwind end of leads. Remove slip ring attaching screw, lockwasher and flat washer and slip rings.

16. If rear bearing requires replacement, remove with Universal Puller Plate and arbor press. Bearing must be replaced, if removed.

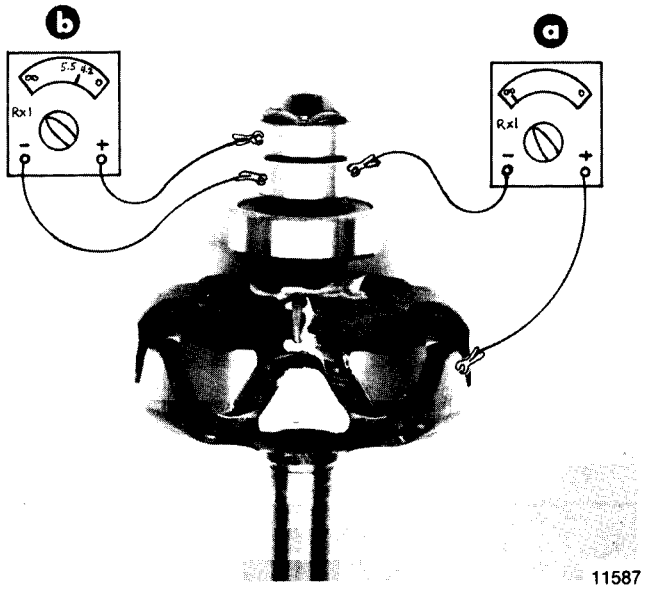
INSPECTION and CLEANING

1. Clean all parts with a clean, soft cloth. Do not use solvent, or electrical components may be damaged.
2. Inspect the following parts:
   a. **Brush set** - inspect for cracked porcelain casing, damaged brush leads, poor brush lead solder connections, weak or broken brush springs or worn brushes. Replace brush set if brushes are less than ½" (6.5mm) long.
   b. **Rotor** - inspect for stripped threads, worn keyway, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).
   c. **Rotor slip rings** - clean slip rings with 400 grain (or finer) polishing cloth while spinning rotor in a lathe. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-rounders [.002" (0.5mm) maximum] and replace, if required.
   d. **Rotor shaft bearings** - inspect for damaged seals, lack of lubrication, discoloration (from overheating) or excessive side or end play. Hold inner race of bearings while turning outer race. Bearing should turn freely without binding or evidence of rough spots.
   e. **Stator** - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.
   f. **Regulator** - inspect leads for damaged insulation.
   g. **Front and rear end frames** - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). End frame(s) must be replaced, if bearing has spun. Also, inspect bearing retainer recess in front end frame for damage.
   h. **Fan** - inspect for cracked or bent fins, broken welds (bi-directional fan only) or worn mounting hole (from fan spinning on shaft).
   i. **Pulley** - inspect pulley mounting bore and key groove for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, or corrosion. Repair, if possible, with a fine file and a wire brush or replace pulley. Drive surfaces must be true and smooth, or drive belt wear will be greatly accelerated.
   j. **Alternator** - if alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, because of centrifugal force. Replace rotor, if all other electrical components test good.

COMPONENT TESTING

Rotor

1. **(TEST 1),** rotor field circuit for grounds, using an ohmmeter (set on Rx1 scale) as follows:
   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.
   b. Meter should indicate no continuity (meter should not move).
   c. If continuity does exist, rotor field circuit is grounded. Inspect slip ring terminals to be sure that they are not bent and touching rotor shaft. Also be sure that excess solder is not grounding terminals to rotor shaft. If cause for ground cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter between one of the leads and rotor shaft or pole pieces. If continuity still exists, replace rotor assembly. If continuity is eliminated, replace slip rings.



2. **(TEST 2),** rotor field circuit for opens, shorts or high resistance, using an ohmmeter (set on Rx1 scale), as follows:
   a. Connect one ohmmeter lead to each slip ring.
   b. Ohmmeter reading should be 4.2 to 5.5 ohms with rotor at room temperatur [70°-80° F (21°-26° C)].

c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, replace slip rings. If reading is still high or infinite, replace complete rotor assembly.

d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, slip rings are shorted and must be replaced. If reading is still low, rotor field windings are shorted, and complete rotor assembly must be replaced.

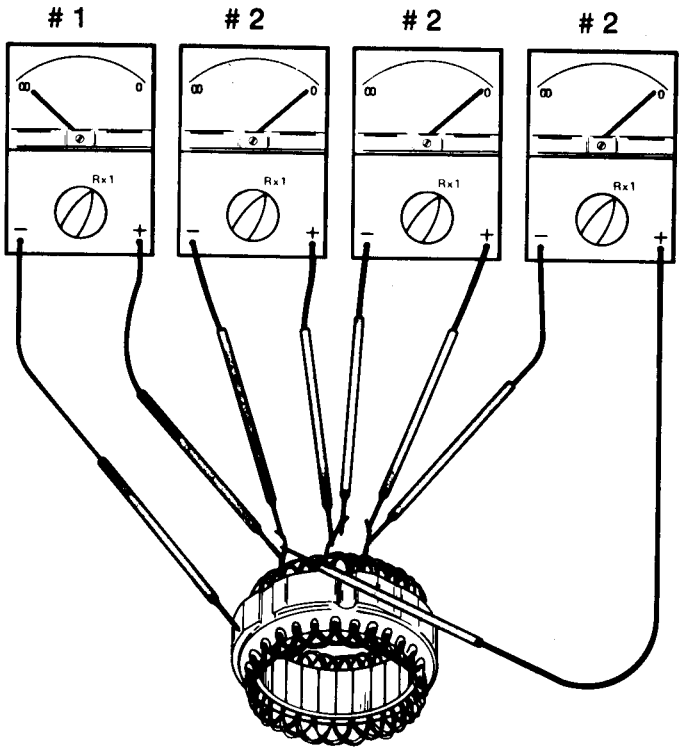
STATOR

IMPORTANT: Stator leads must be disconnected from rectifier diodes and diode trio for this test.

1. **(TEST 1),** Test stator for grounds, using an ohmmeter (set on Rx1 scale) as follows:

   a. Connect one lead of ohmmeter or test lamp to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.

      Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.



2. **(TEST 2),** for opens in stator, using an ohmmeter (set on Rx1 scale) as follows:

   a. Connect ohmmeter or test lamp between each pair of stator windings (3 different ways). Either of the 2 leads (coming from each stator windings) may be used.

      Continuity should be present in all 3 cases (meter should move); if it does not, one or more of the windings are open and stator must be replaced.

3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discolorations, as this usually is a sign of a short.

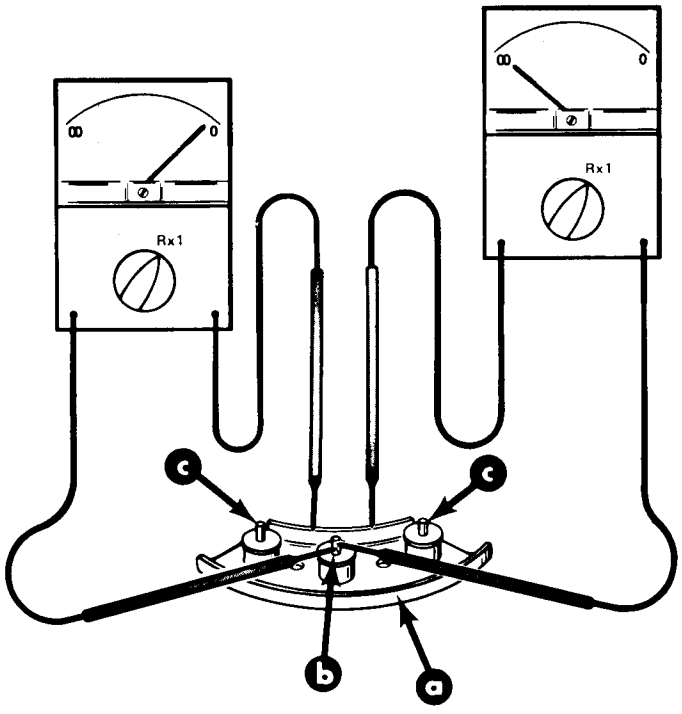
Negative (-) Rectifier Diodes

IMPORTANT: Rectifier diodes must be disconnected from stator for this test.

⚠CAUTION
Do not use a test instrument with more than a 12-volt source as rectifier diodes may be damaged.

1. Connect one lead of an ohmmeter (set on Rx1 scale) to negative (-) rectifier diode heat sink and the other lead to one of the rectifier diode terminals. Note the reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are low, diode is shorted.

4. Repeat Steps 1-thru-3 for 2 other rectifier diodes in heat sink.
5. Replace complete rectifier set, if any one of the diodes is shorted or open.



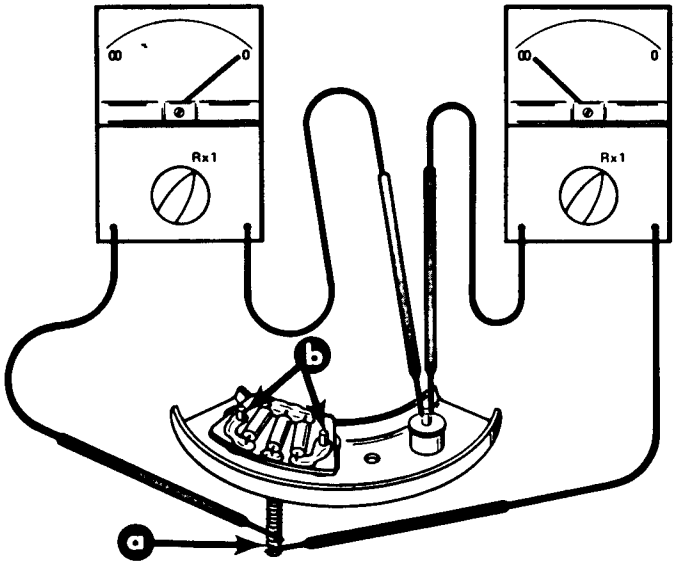
a - Heat Sink
b - Diode Terminal
c - Test These 2 Diodes in Same Manner

Positive (+) Rectifier Diodes and Diode Trio

⚠CAUTION

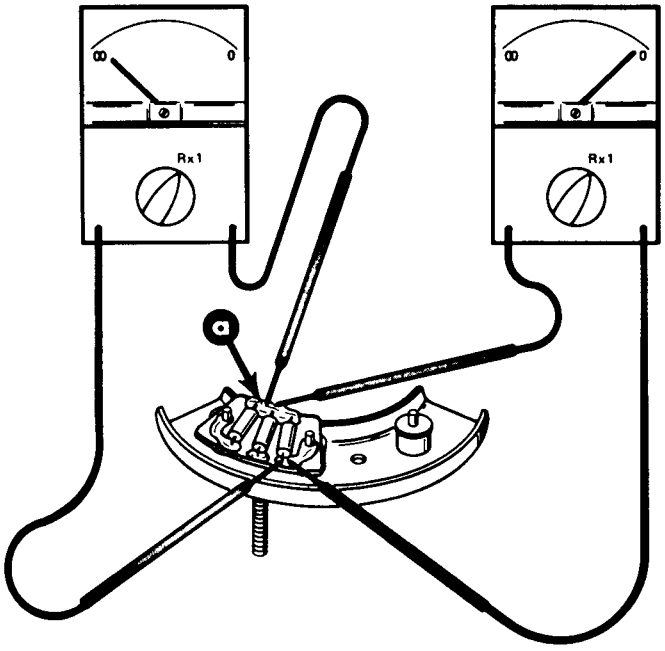
Do not use a test instrument with more than a 12-volt source (in the following test), as rectifier diodes may be damaged.

1. Connect one lead of an ohmmeter (set on Rx1 scale) to ⅛" stud on positive (+) rectifier heat sink and the other lead to one of the rectifier diode terminals. (Note: Two of the diode terminals come up the the diode trio circuit board.) Note the meter reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
4. Repeat Steps 1-thru-3 for 2 other rectifier diodes in heat sink.
5. Replace complete rectifier set, if any one of the diodes is shorted or open.



a - Stud
b - Repeat Test between These Terminals and Stud

6. Connect one lead of an ohmmeter (set on Rx1) scale to the common side on the diode trio circuit board and the other lead to the other side of one of the three (3) trio diodes. Note the reading.
7. Reverse leads and again note reading.
8. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode trio is open. If both readings are low, diode trio is shorted.
9. Repeat Steps 6-thru-8 for the other 2 diodes.
10. Replace positive (+) rectifier and diode trio assembly if any one of the diodes is shorted or open.



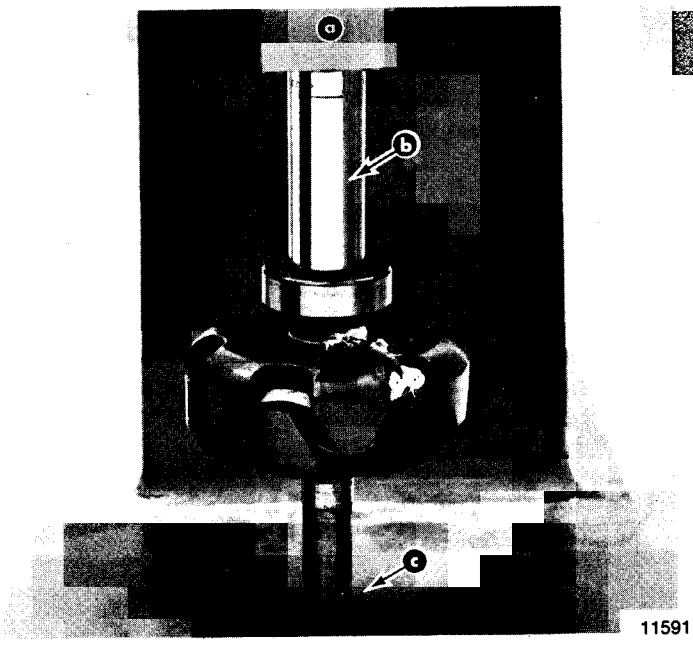
a - Common Side of Diode Trio Circuit Board

Condenser

1. Using Magneto Analyzer 91-76032 and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd)
   b. Condenser Short or Leakage Test
   c. Condenser Series Resistance Test
2. Replace condenser, if test results are not within specifications.

REASSEMBLY

1. Press new rear bearing all-the-way onto rotor shaft (until inner race contacts shoulder) with an arbor press and a bearing driver that contacts inner bearing race only, as shown. Use extreme care to prevent damage to field winding leads.

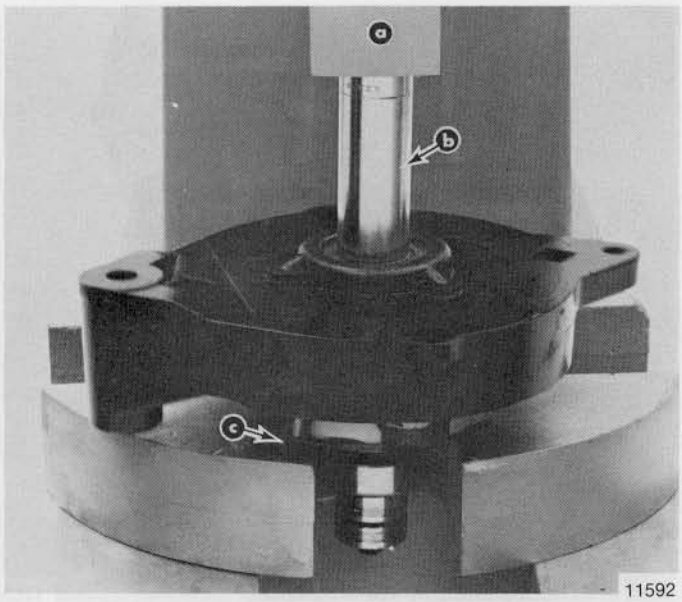


a - Arbor Press
b - Bearing Driver (Must Contact Inner Bearing Race Only)
c - Support Pulley End of Shaft on Arbor Press Base (DO NOT Support Rotor on Pole Pieces

IMPORTANT: Be sure to support rotor on end of shaft and not on pole pieces, as pole pieces are only press-fit onto shaft.

2. Insert field winding leads thru passage in slip ring hub, then hand-press slip rings onto shaft while maintaining proper alignment with leads and passage. Install cap screw, lockwasher and flat washer. Torque screw to specifications.
3. Wrap ends of field winding leads around slip ring terminals and solder with rosin core solder. Do not use excessive solder. Also, do not use excessive heat, or insulation on field winding leads may be damaged.

4. Press new front bearing into front end frame bearing bore. If necessary, use a bearing driver that contacts outer race only. Install bearing retainer into recess in end frame (with ears outward and aligned with opening), using a long nose pliers and a punch. Use extreme care to prevent damage to front bearing seal. Be sure that retainer is fully seated in groove (ears should touch both sides of recess).
5. Press front end frame and bearing assembly onto rotor shaft (until inner bearing race contacts shoulder) with an arbor press and a bearing driver that fits over shaft and contacts inner bearing race only, as shown. Be sure to support rotor on pole pieces only.

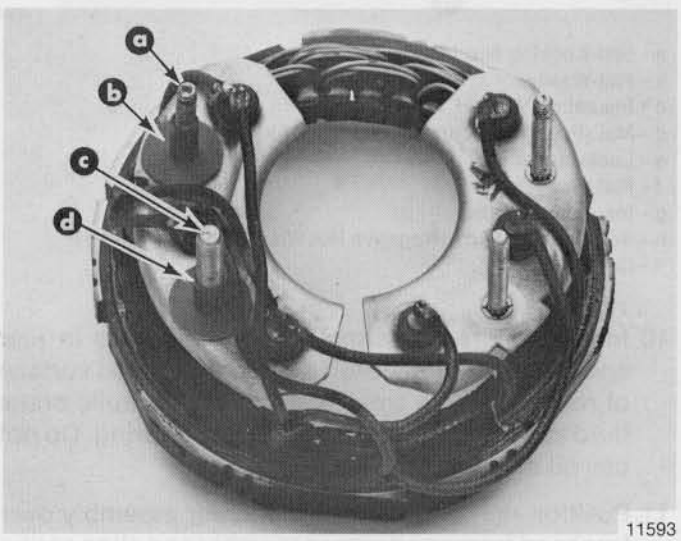


a - Arbor Press
b - Bearing Driver (Must Contact Inner Bearing Race Only)
c - Support Rotor on Pole Pieces

⚠CAUTION
Do not clamp vise on rotor pole pieces when tightening pulley nut or pole pieces may be distorted.

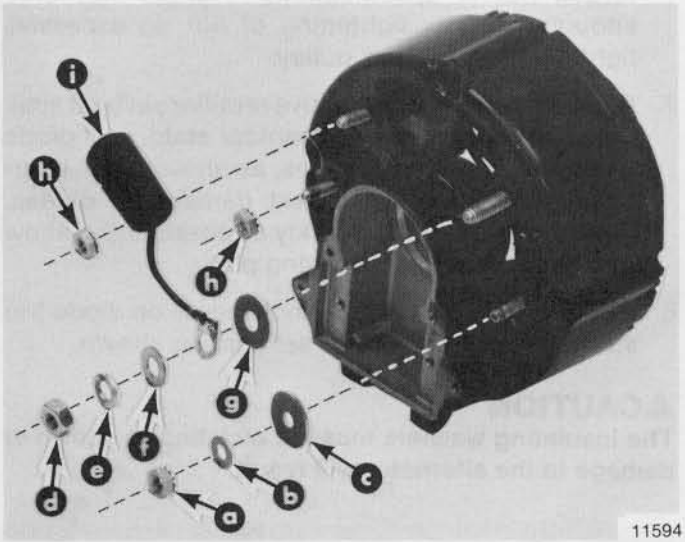
6. Slide fan spacer onto rotor shaft. Install new woodruff key, then install fan, pulley, lockwasher and nut on shaft. Clamp pulley in a vise, using protective jaws or an old oversize V-belt to protect pulley and torque nut to specifications. Tighten vise only enough to allow tightening of nut, as excessive tightening may distort pulley.
7. Position diode trio in positive rectifier set heat sink. Using rosin core solder, resolder stator and diode trio leads to rectifier diodes, as shown. Use long-nose pliers to prevent heat damage to diodes. Solder connection as quickly as possible and allow them to cool before removing pliers.
8. Place insulating washers and sleeves on diode trio stud and positive rectifier set stud, as shown.

⚠CAUTION
The insulating washers must be installed as shown or damage to the alternator will result.



a - Diode Trio Stud
b - Small Insulating Washer and Sleeve
c - Positive Rectifier Set Stud
d - Large Insulating Washer and Sleeve

9. Guide rear end frame onto diode trio and rectifier diode set studs, then install condenser, insulating washers, flat washers, lockwashers and nuts, as shown. Tighten nuts to specifications.



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a - Self-Locking Nut (Diode Trio Stud)
b - Flat Washer
c - Insulating Washer
d - Nut (Positive Rectifier Diode Set Stud)
e - Lockwasher
f - Flat Washer
g - Insulating Washer
h - Self-Locking Nuts (Negative Rectifier Diode Set Studs)
i - Condenser

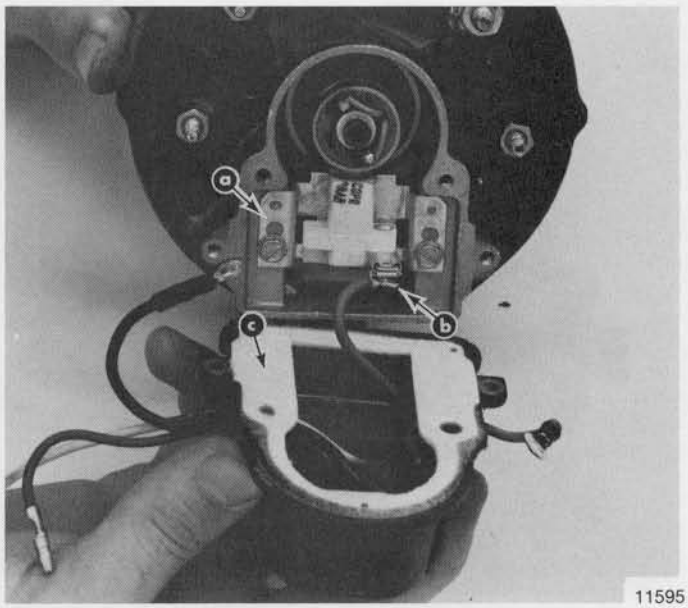
10. Install new rear bearing retainer in recess in rear end frame bearing bore. Lubricate exposed surface of retainer with a small amount of hydraulic brake fluid to ease assembly over the rear bearing. Do not use oil or grease.

11. Position rear end frame and stataor assembly over front end frame and rotor assembly and align scribe marks on each (scribed during disassembly). Hand-press end frames together, then install thru bolts and nuts. Torque bolts evenly to specifications.

12. Place brush set in rear end frame cavity and secure with mounting screws. Be sure to use outer-most mounting holes. Torque screws to specifications.

13. Position felt seal on regulator mounting surface. Connect regulator field lead to brush terminal then mount regulator with screws. Torque screws to specifications. Connect regulator leads to regulator terminal and ground terminal and secure with lockwashers and nuts. Torque nuts to specifications.

⚠CAUTION
Regulator field lead must be connected as shown or lead may be damaged by rotor slip rings during operation.



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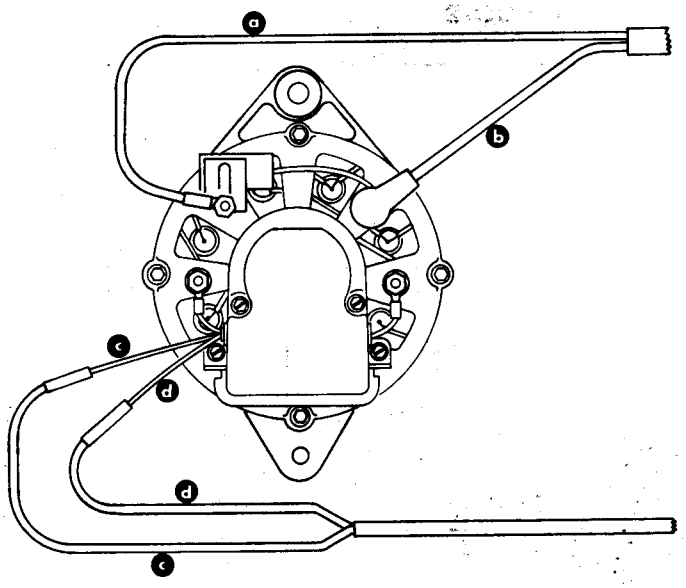
INSTALLATION

1. Position alternator in mounting bracket and install mounting bolt, washers (if used), spacer and nut. Place washers (if used) on each side of spacer. Do not tighten nut securely at this time.
2. Fasten alternator brace to alternator with bolt, washers and spacer (if used). Do not tighten bolt at this time.
3. Position alternator drive belt on pulleys and adjust tension as explained under "Drive Belt Replacement and Adjustment", following.
4. Reconnect wiring harness to alternator and negative battery cable to battery.

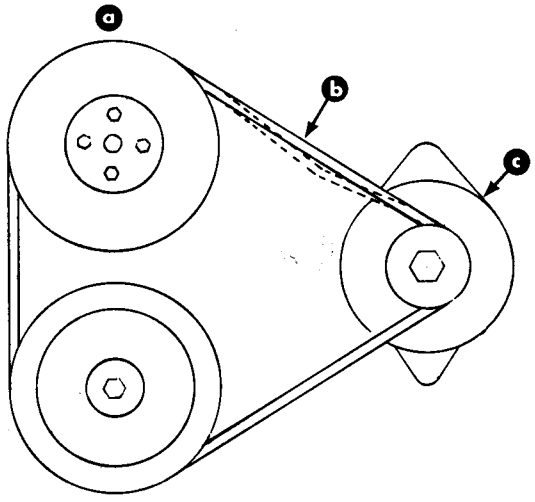


a - Black
b - Orange
c - Purple
d - Red-Purple

Drive Belt Replacement and Adjustment

IMPORTANT: When adjusting drive belt tension Do not apply pressure to alternator rear end frame, as alternator may be damaged.

1. Check belt tension by depressing belt with thumb at midway point. Belt should depress ↑" (13mm).

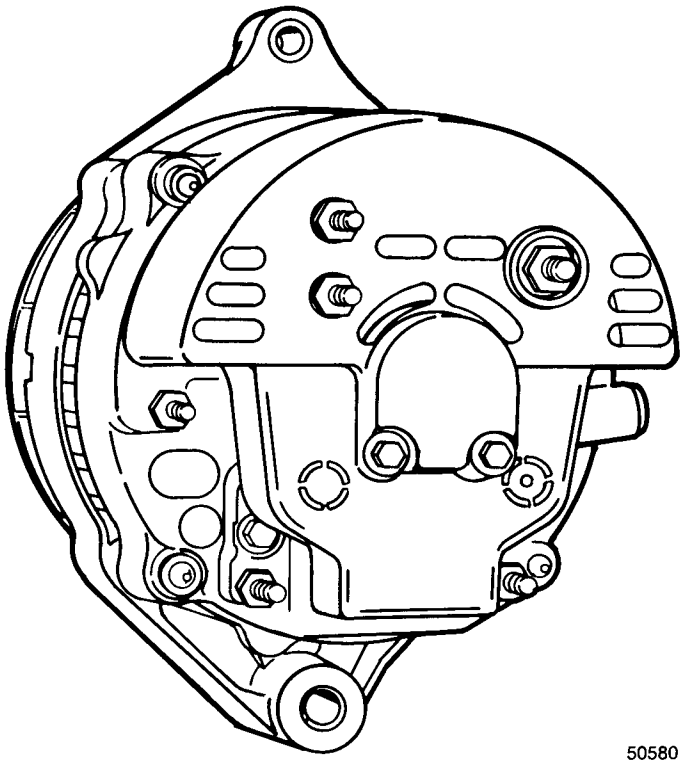


a - Circulating Pump Pulley
b - Check Point
c - Alternator

2. If adjustment or replacement is necessary, loosen alternator brace attaching bolts and alternator mounting bolt.
3. Pivot alternator inward to replace drive belt.
4. Pivot alternator outward, as required, to obtain correct belt tension. Apply pressure to alternator front end frame only. Set new belts at high reading.
5. Retighten alternator brace attaching bolts and alternator mounting bolt securely.
6. Recheck drive belt tension.

Identification

Prestolite (Motorola)



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Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Prestolite (Motorola)-Alternator

Specifications

Voltage Output	13.8 - 14.8 Volts
Current Output	51 Amps
Excitation Circuit	1.5 - 3.0 Volts
Condenser Capacity	.5 MFD
Minimum Brush Length	3/16 in. (4.76mm)

Special Tools

Multi-Meter/DVA Tester	91-99750
Magneto Analyzer	91-76032

Torque Specifications

Housing Screws	50 - 60 lb. in. (5.6 - 6.7 N.m)
Pulley Nut	35 - 50 lb. ft. (48 - 68 N.m)
Front Bearing Screws	25 -35 lb. in. (2.8 - 3.9 N.m)
Alternator Mount	35 lb. ft. (48 N.m)
Adjustment Bolt	16 lb. ft. (28 N.m)
Tighten All Other Fasteners Securely	
V-Belt Tension (Note 1)	Depress 1/2 in.

NOTE 1: Depress Belt With Thumb At Midway Point Between Circulating Pump Pulley and Alternator Pulley

Sealants

Liquid Neoprene	92-25711
Heat Sink Compound	Obtain Locally

Description

The alternator employs a rotor, which is supported in 2 end frames by ball bearings, and is driven (via a pulley) at approximately twice engine speed. The rotor contains a field winding that is enclosed between 2 multiple-finger pole pieces. The ends of the field winding are connected to 2 brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between the 2 end frames. It consists of 3 windings wound 120° electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains 6 diodes which are arranged so that current flows from ground, thru the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator also is not required, as the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifier and stator. A capacitor also is utilized to protect the rectifier system from high voltages and to suppress radio noise.

Diagnosis on Engine

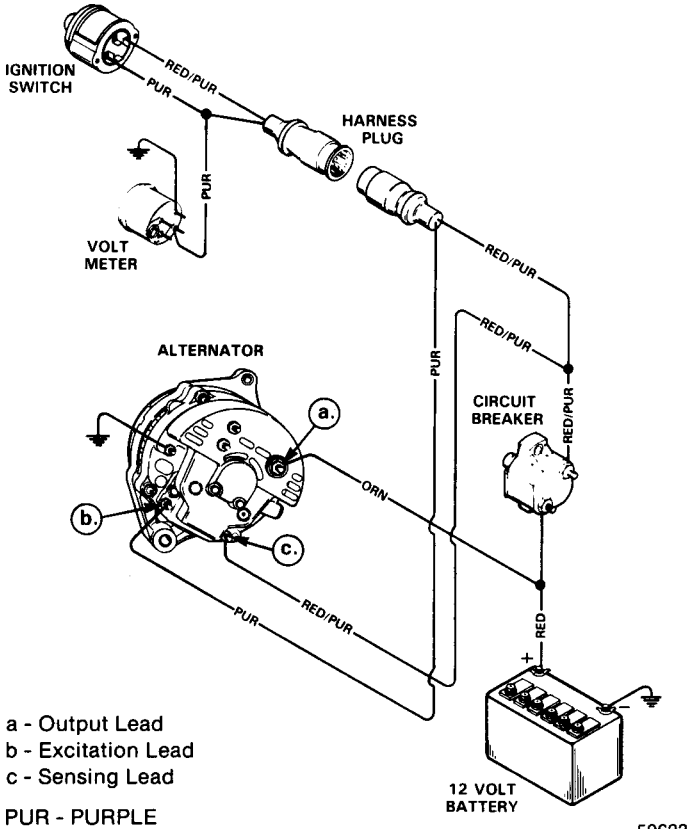
Before proceeding with the tests, perform the following checks to eliminate possible problem areas. Also observe "Precautions," immediately preceding, to prevent damage to alternator system.

1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery. Battery must be at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt and replace if necessary. Also, check tension and adjust if necessary, as outlined under "Drive Belt Replacement and Adjustment."

System Components

The alternator system, used on engines with Prestolite Alternators consists of the alternator, battery, the ignition switch and the wiring which connects these components.

Typical Charging Circuit



a - Output Lead
b - Excitation Lead
c - Sensing Lead

PUR - PURPLE
ORN - ORANGE

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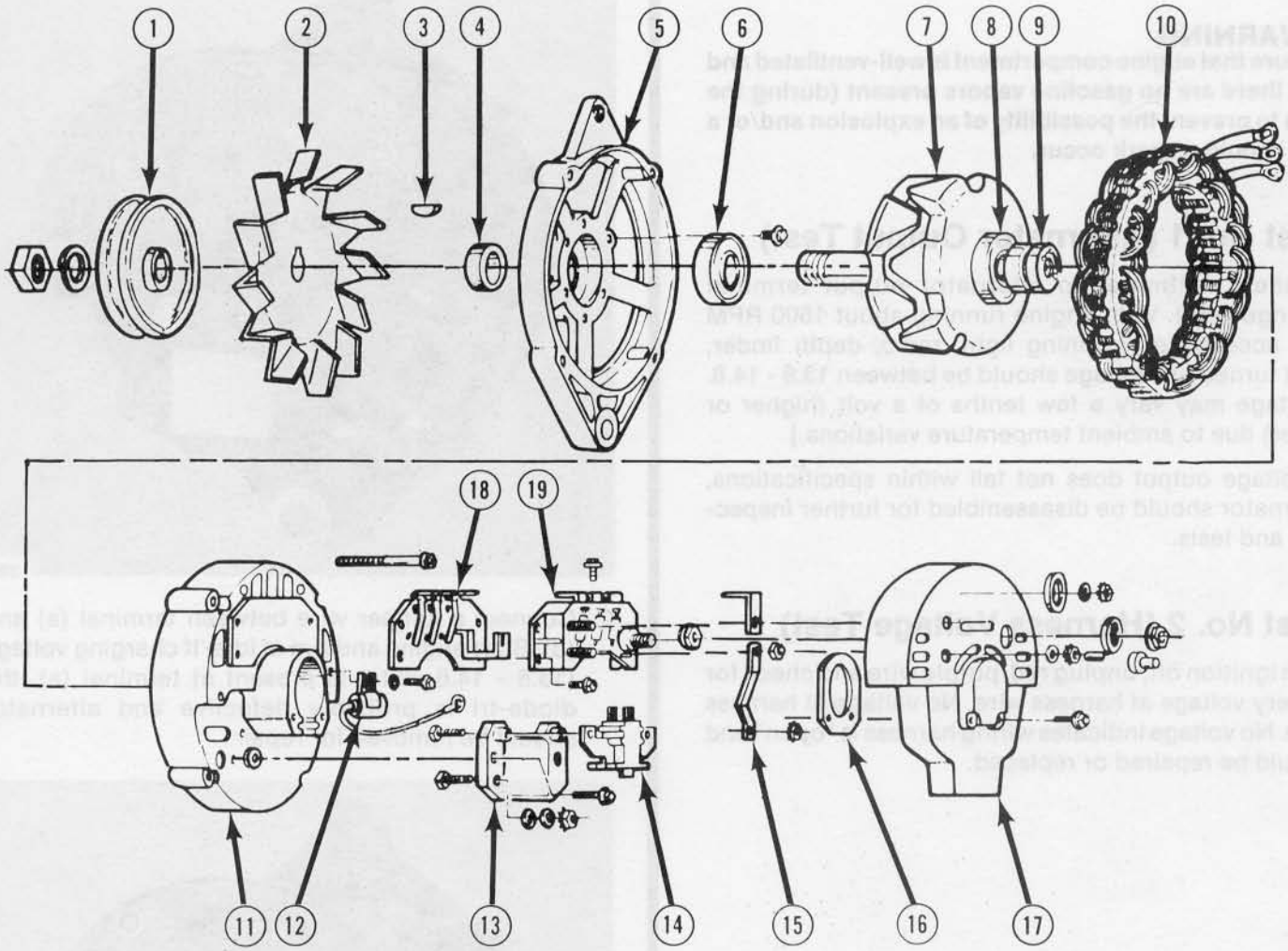
Precautions

The following precautions must be observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. Do not attempt to polarize the alternator.
2. Do not short across or ground any of the terminals on the alternator, except as specifically instructed.
3. Never diconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. Never disconnect regulator lead from alternator regulator terminal when the alternator is being driven by engine.
5. Always remove negative (-) battery cable from battery before working on alternator system.
6. When installing battery, be sure to connect the negative (-) (grounded) battery cable to negative (-) battery terminal and positive (+) battery cable to positive (+) battery terminal.
7. If a charger or booster battery is to be used. Be sure to connect it in parallel with existing battery (positive to positive; negative to negative).

Exploded View



1 - Pulley
2 - Fan
3 - Woodruff Key
4 - Fan Spacer
5 - Front Housing
6 - Front Bearing
7 - Rotor
8 - Rear Bearing
9 - Slip Rings

10 - Stator
11 - Rear Housing
12 - Capacitor
13 - Voltage Regulator
14 - Brush Assembly
15 - Strap
16 - Felt Gasket
17 - Cover
18 - Rectifier Bridge
19 - Diode Trio

Alternator/Regulator Tests

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

⚠WARNING
Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

Test No. 1 (Alternator Output Test)

Connect voltmeter to alternator output terminal (orange wire). With engine running about 1500 RPM and accessories (running light, radio, depth finder, etc.) turned on, voltage should be between 13.8 - 14.8. [Voltage may vary a few tenths of a volt (higher or lower) due to ambient temperature variations.]

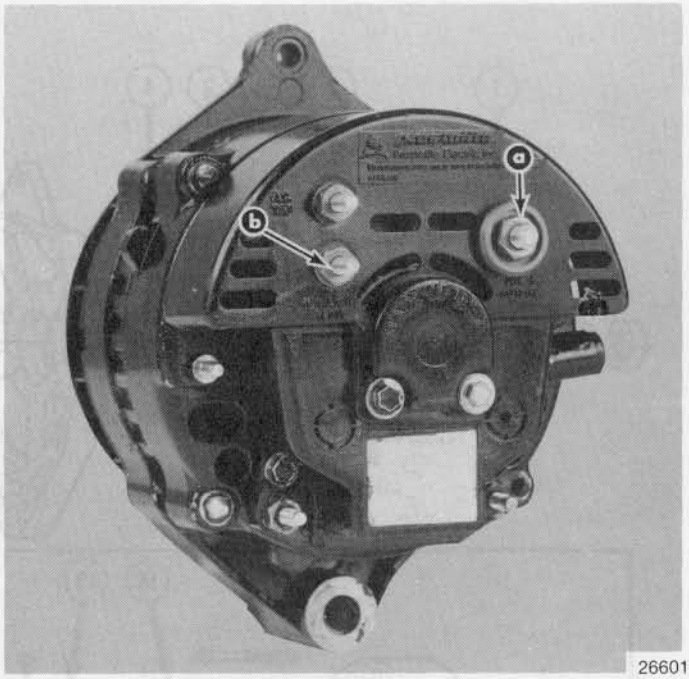
If voltage output does not fall within specifications, alternator should be disassembled for further inspection and tests.

Test No. 2 (Harness Voltage Test)

With ignition off, unplug red/purple wire and check for battery voltage at harness wire. No voltage at harness wire. No voltage indicates wiring harness is "open" and should be repaired or replaced.

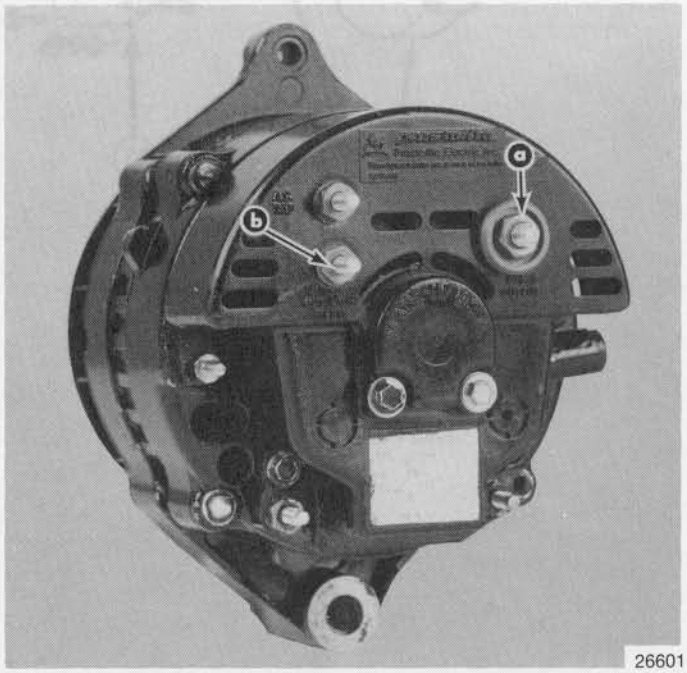
Test No. 3 (Open Diode-Trio Test)

1. With ignition on and engine not running, check for battery voltage at terminal (a) and 1.5 to 3.0 volts at termainal (b).



26601

2. Connect a jumper wire between terminal (a) and (b). Start engine and run at idle. If charging voltage (13.8 - 14.8 volts) is present at terminal (a), the diode-tri is probably defective and alternator should be removed for repair.



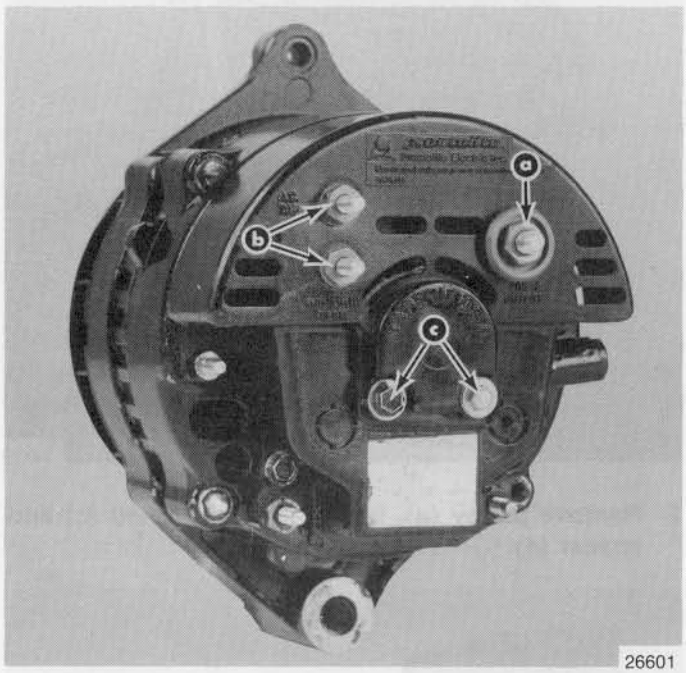
26601

Test No. 4 (Open Regulator Test)

IMPORTANT: This test requires removal of back cover of alternator.

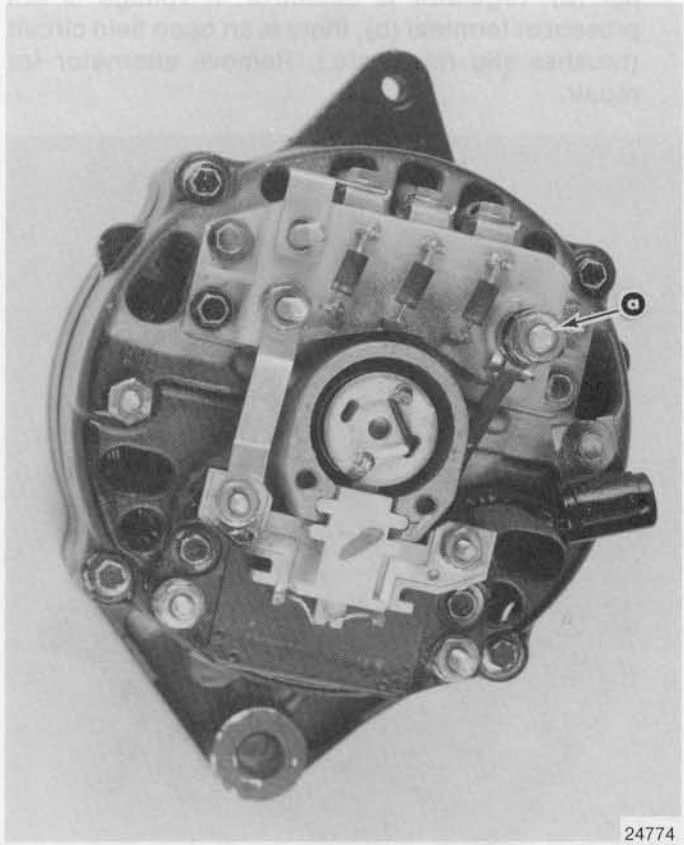
⚠CAUTION
To prevent electrical system damage and/or sparks, disconnect battery cables at battery before removing wiring from alternator.

1. Disconnect battery cables at battery.
2. Disconnect output wire and remove terminal nut (a). Remove nuts (b) and screws (c). Remove cover.



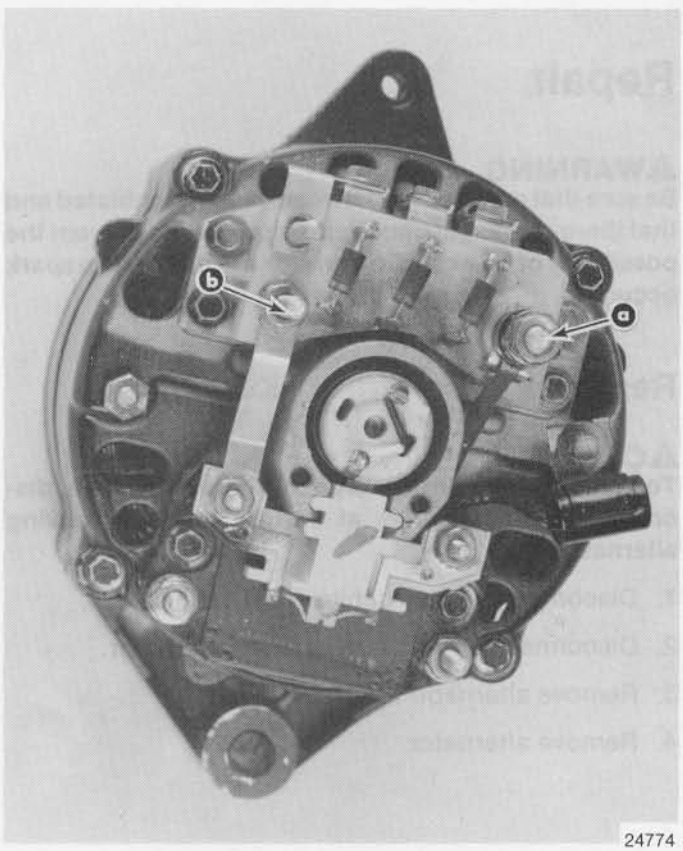
26601

3. Reconnect output wire on terminal (a). Reconnect battery cables.



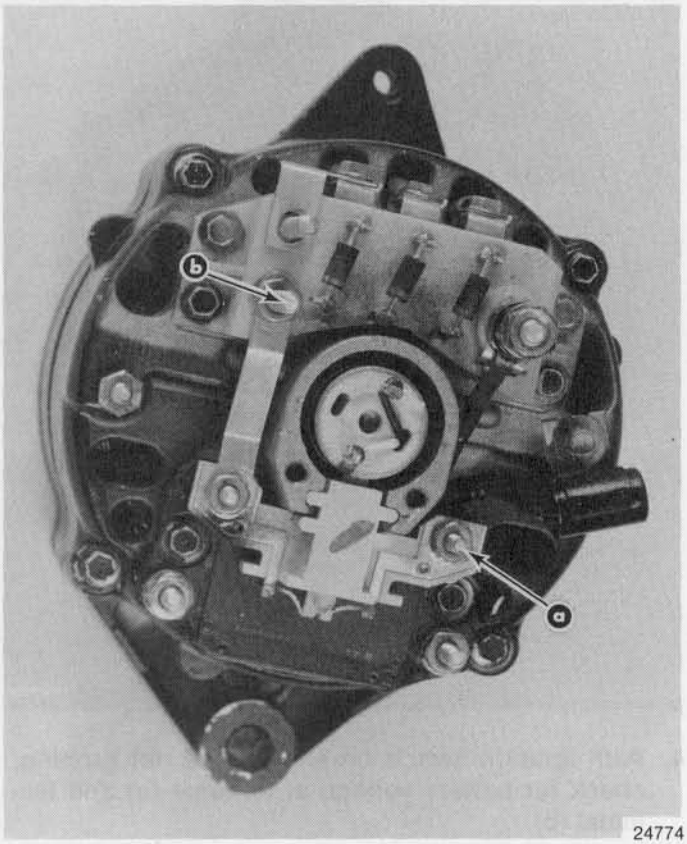
24774

4. With ignition switch on and engine not running, check for battery voltage at terminal (a) and terminal (b).



24774

5. Connect a jumper wire between field terminal (a) and ground. If 1.5 to 3.0 volts are present at terminal (b), regulator is defective. If voltage is not present at terminal (b), there is an open field circuit (brushes slip rings, etc.). Remove alternator for repair.



24774

Repair

⚠WARNING
Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present to prevent the possibility of an explosion and/or a fire, should a spark occur.

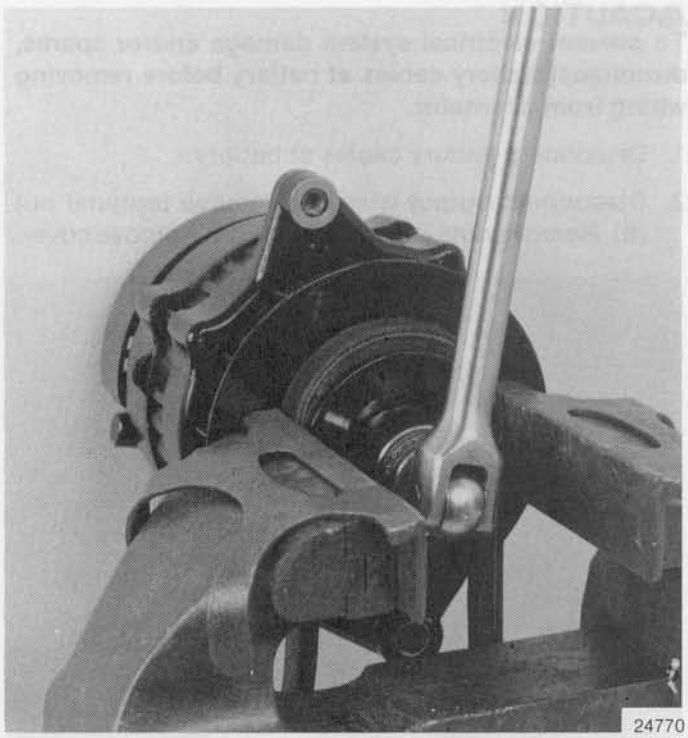
Removal

⚠CAUTION
To prevent sparks or damage to electrical system, disconnect battery cables at battery before removing alternator.

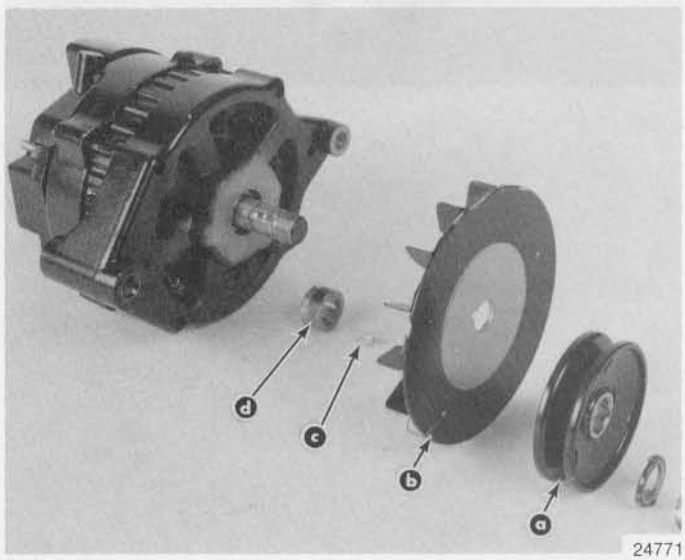
1. Disconnect battery cables from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternaotr belt.
4. Remove alternator.

Disassembly

1. Using an oversized v-belt to protect the pulley, clamp alternator in vise as shown. Remove pulley nut.

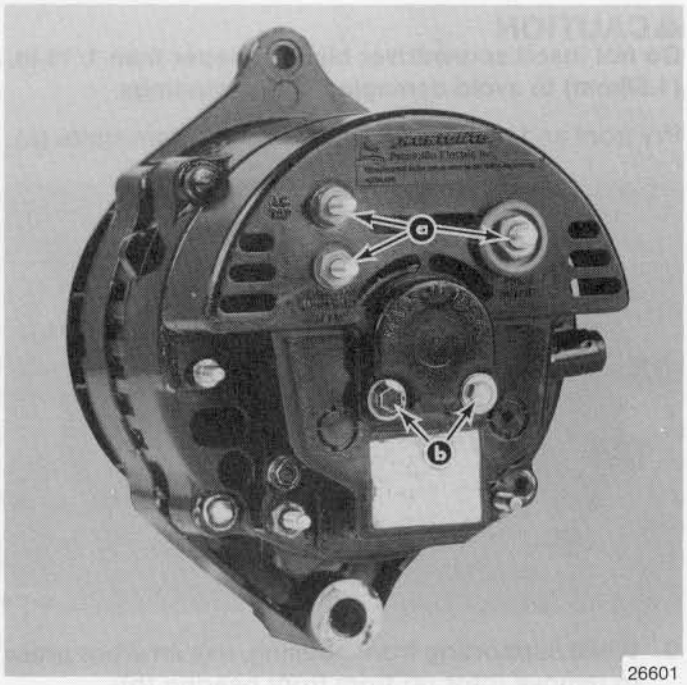

24770

2. Remove pulley (a), fan (b), woodruff key (c) and spacer (d).



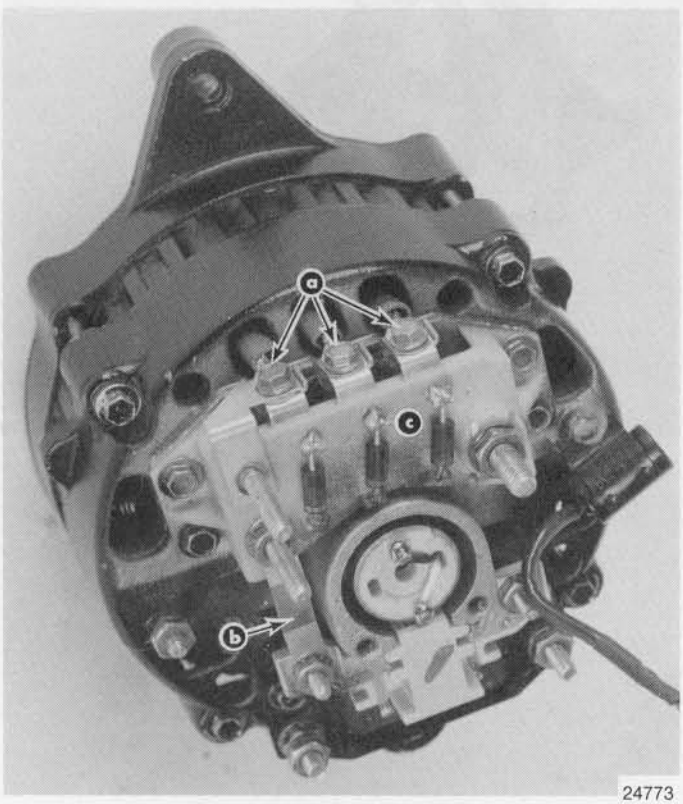
24771

3. Remove nuts (a) and screws (b) to remove rear cover.



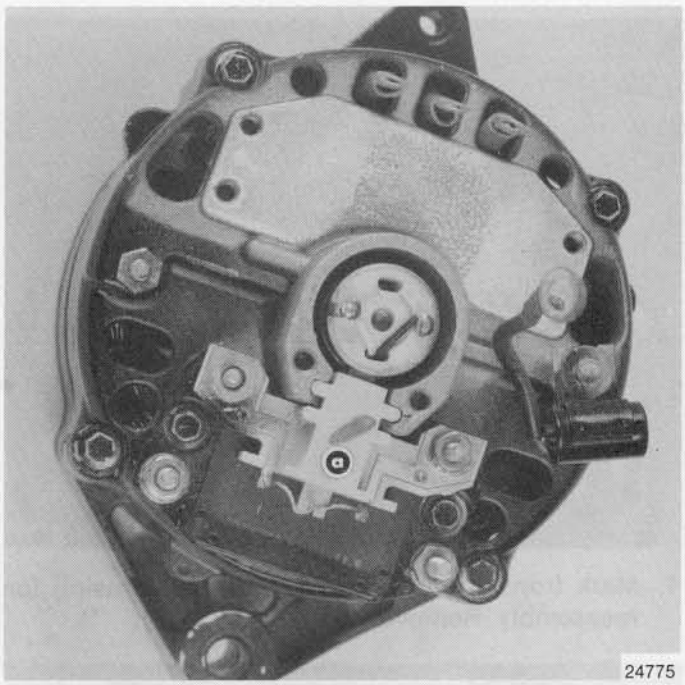
26601

4. Disconnect stator wires (a). Remove strap (b). Remove diode trio and rectifier bridge (c).



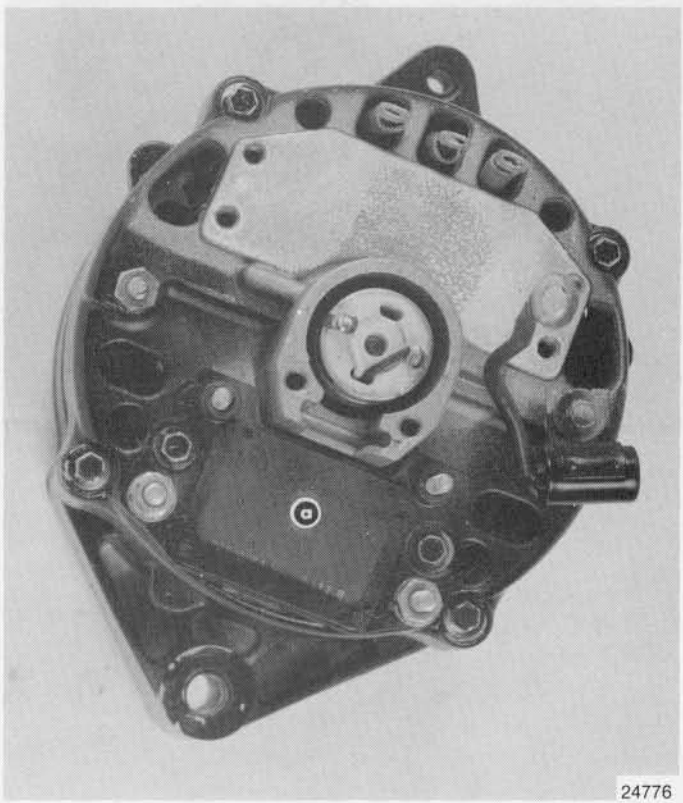
24773

5. Remove brush holder (a).



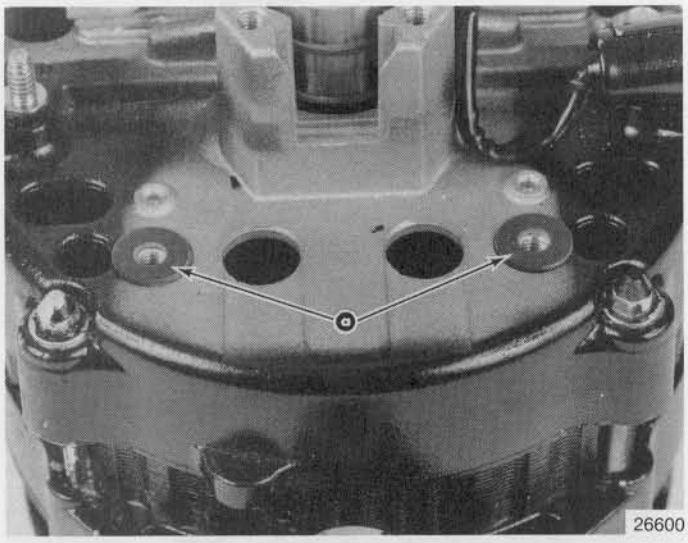
24775

6. Remove regulator (a).

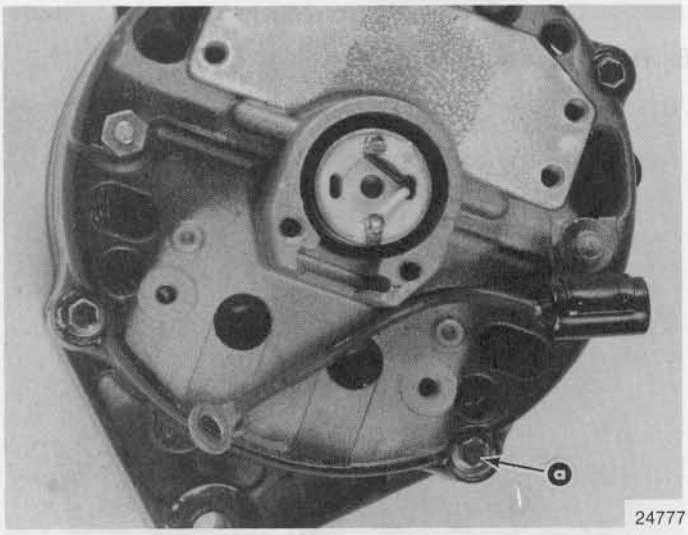


24776

IMPORTANT: Do not lose fiber washers (a).



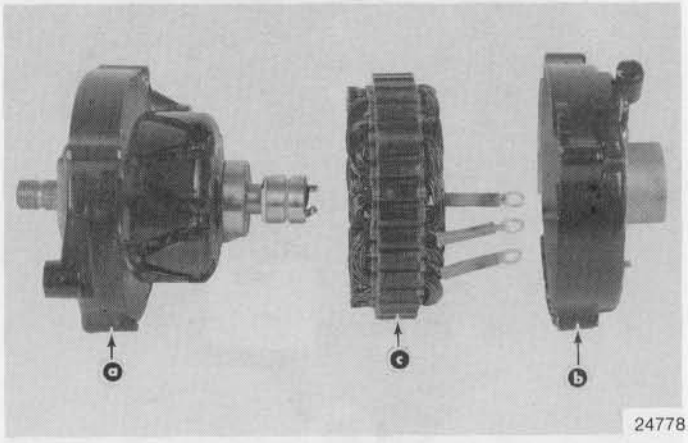
7. Mark front housing, stator, and rear housing for reassembly. Remove four (4) screws (a).



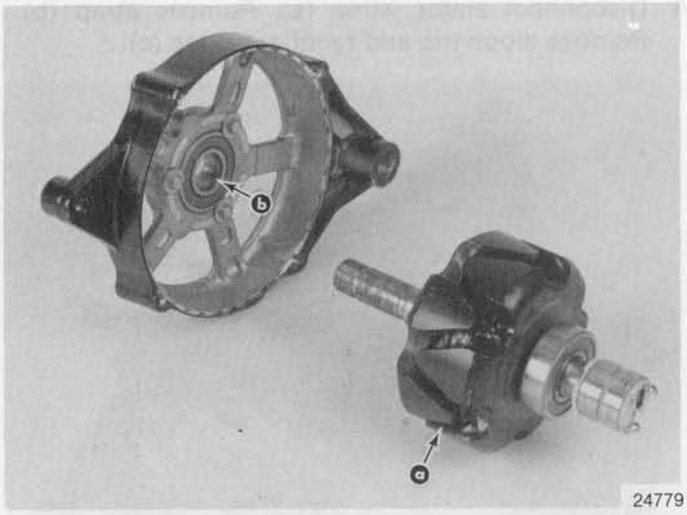
8. Carefully insert two screwdriver blades in opposite openings between stator and front housing.

⚠CAUTION
Do not insert screwdriver blades deeper than 1/16 in. (1.58mm) to avoid damaging stator windings.

Pry front and rear housings, (a) and (b), from stator (c).



9. While supporting front housing, use an arbor press to remove rotor (a) from front bearing (b).



Inspection and Cleaning

1. Clean all parts with a clean, soft cloth. Do not use solvent, or electrical components may be damaged.
2. Inspect the following;
   a. **Brush set** - inspect for cracked porcelain casing, damaged brush leads, poor brush springs or worn brushes. Replace brush set if brushes are less than 3/16 in. (4.76mm) long.
   b. **Rotor** - inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).
   c. **Rotor slip rings** - clean slip rings with 400 grain (or finer) polishing cloth. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-round [.002" (.05mm) maximum]. Replace if defective.
   d. **Rotor shaft bearings** - inspect for damaged seals, lack of lubrication, discoloration (from overheating) or excessive side or end play. Hold inner race of bearings while turning outer race. Bearing should turn freely without binding or evidence of rough spots.
   e. **Stator** - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.
   f. **Regulator** - inspect leads for damaged insulation.
   g. **Front and rear housings** - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). Replace if defective.
   h. **Fan** - inspect for cracked or bent fins, broken welds or worn mounting hole (from fan spinning on shaft).
   i. **Pulley** - inspect pulley mounting bore and for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, or corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush or replace pulley. Drive surfaces must be true and smooth, or drive belt wear will be greatly accelerated.
   j. **Alternator** - if alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, because of centrifugal force. Replace rotor, if all other electrical components test good.

Front Bearing

Removal

1. Remove retaining screws.
2. Use an arbor press to remove bearing from housing.

Installation

1. Using an arbor press, press on outer race of new bearing until fully seated in housing.
2. Install retaining screws. Tighten to 25 - 35 lb. in. (2.8 - 3.9 N.m).

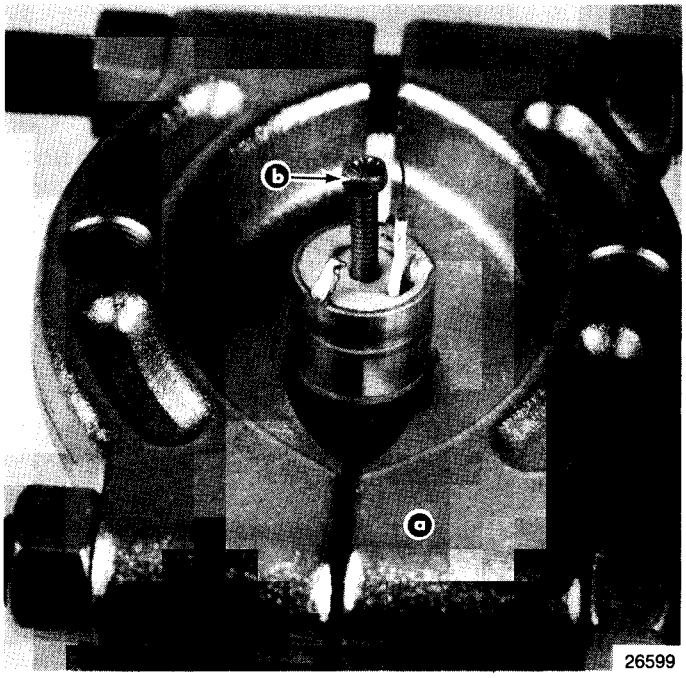
Slip Rings/Rear Bearing

Removal

1. Unsolder wires and carefully unwind them from slip ring terminals.

IMPORTANT: Do not damage rotor wires when removing slip rings or bearing.

2. Install a universal puller plate (a) between bearing and slip rings. Insert a 10 x 1 in. cap screw (b) into opening of slip ring assembly.



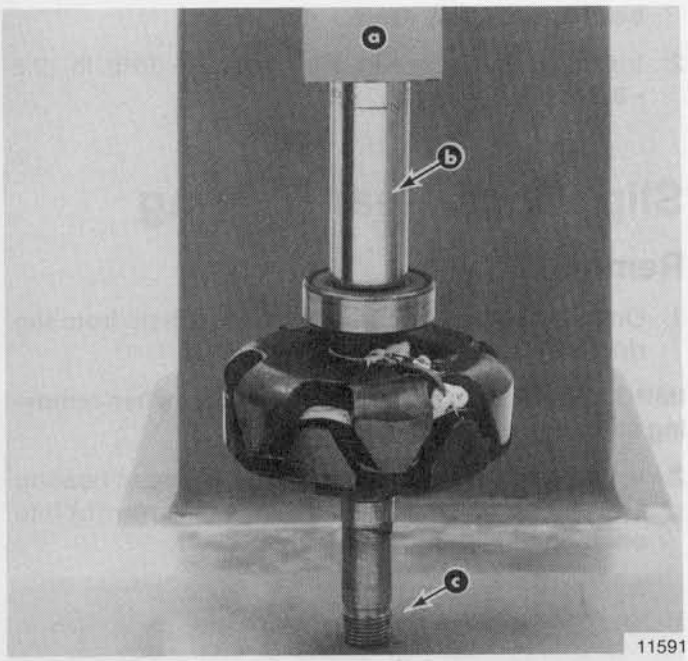
26599

3. Using an arbor press, push against cap screw to remove slip rings.
4. Install a universal puller plate under bearing.
5. Using an arbor press, remove bearing.

Installation

1. Press new rear bearing all-the-way onto rotor shaft (until inner race contacts shoulder) with an arbor press and a bearing driver that contacts inner bearing race only, as shown. Use extreme care to prevent damage to field winding leads.

IMPORTANT: Be sure to support rotor on end of shaft and not on pole pieces, as pole pieces are only press-fit onto shaft.



11591

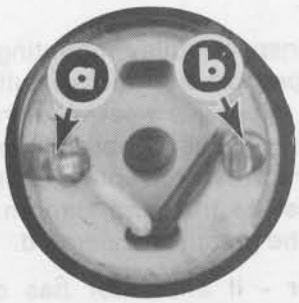
a - Arbor Press
b - Bearing Driver (Must Contact Inner Bearing Race Only)
c - Support Pulley End of Shaft on Arbor Press Base (DO NOT Support Rotor on Pole Pieces

2. Insert wires thru hole in slip rings as shown.

26598

IMPORTANT: Press on the center of slip rings only. Do not bend terminals or pinch wires.

3. Using an arbor press, install slip rings. Press on center of slip rings until they contact shoulder of rotor.
4. Carefully wrap white wire around outer slip ring terminal (a) and black wire around inner slip ring terminal (b). Solder wires in place.



24777

Component Testing

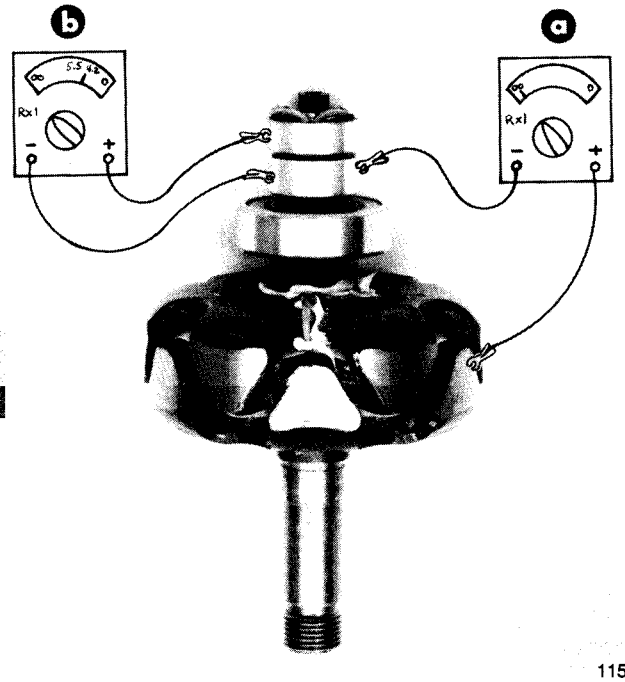
Rotor

1. **(TEST 1),** rotor filed circuit for grounds, using an ohmmeter (set on Rx1 scale) as follows:

   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.

   b. Meter should indicate no continuity (meter should not move).

   c. If continuity does exist, rotor field circuit is grounded. Inspect slip ring terminals to be sure that they are not bent and touching rotor shaft. Also be sure that excess solder is not grounding terminals to rotor shaft. If cause for ground cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter between one of the leads and rotor shaft or pole pieces. If continuity still exists, replace rotor assembly. If continuity is eliminated, replace slip rings.



11587

2. **(TEST 2),** rotor field circuit for opens, shorts or high resistance, using an ohmmeter (set on Rx1 scale), as follows:

   a. Connect one ohmmeter lead to each slip ring.

   b. Ohmmeter reading should be 4.1 to 4.7 ohms with rotor at room temperature [70° - 80° F (21° -26° C)].

   c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, replace slip rings. If reading is still high or infinite, replace complete rotor assembly.

   d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, slip rings are shorted and must be replaced. If reading is still low, rotor field windings are shorted, and complete rotor assembly must be replaced.

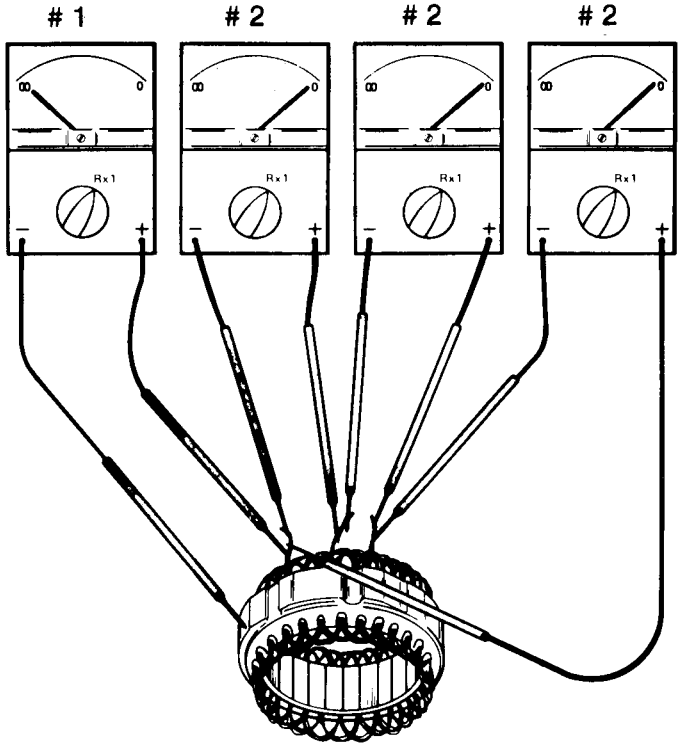
Stator

IMPORTANT: Stator leads must be disconnected from rectifier diodes and diode trio for this test.

1. **(TEST 1),** Test stator for grounds, using an ohmmeter (set on Rx1 scale) as follows:

   a. Connect one lead of ohmmeter or test lamp to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.

   Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.



2. **(TEST 2),** for opens in stator, using an ohmmeter (set on Rx1 scale) as follows:

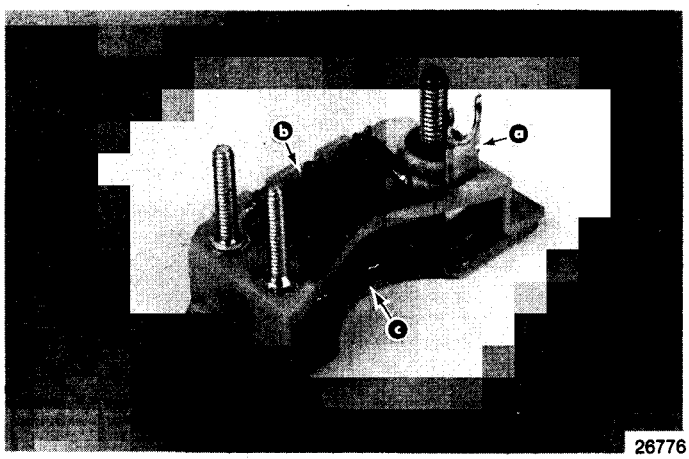
   a. Connect ohmmeter or test lamp between each pair of stator windings (3 different ways). Either of the 2 leads (coming from each stator windings may be used.

      Continuity should be present in all 3 cases (meter should move); if it does not, one or more of the windings are open and stator must be replaced.

3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discolorations, as this usually is a sign of a short.

Rectifier Bridge/Diode Trio Assembly

Straighten strap (a) as shown. Pull diode trio (b) and rectifier bridge (c) apart.



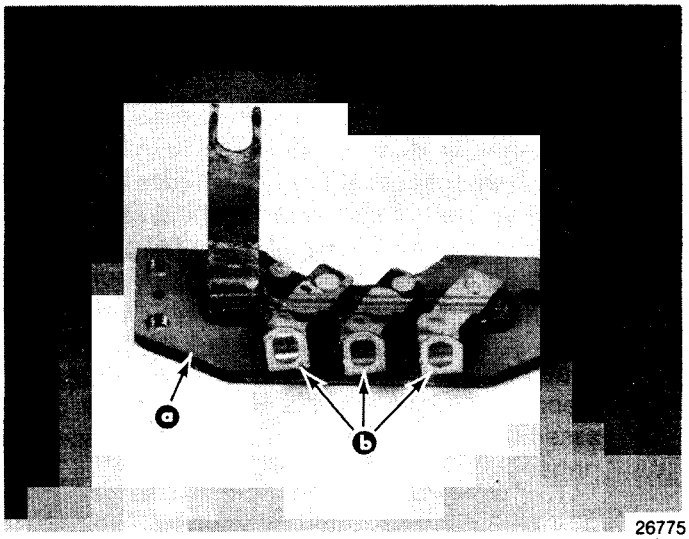
26776

⚠CAUTION
Do not use a test instrument with more than a 12-volt source (in the following test), as rectifier diodes may be damaged.

IMPORTANT: Rectifier diodes must be disconnected from stator for this test.

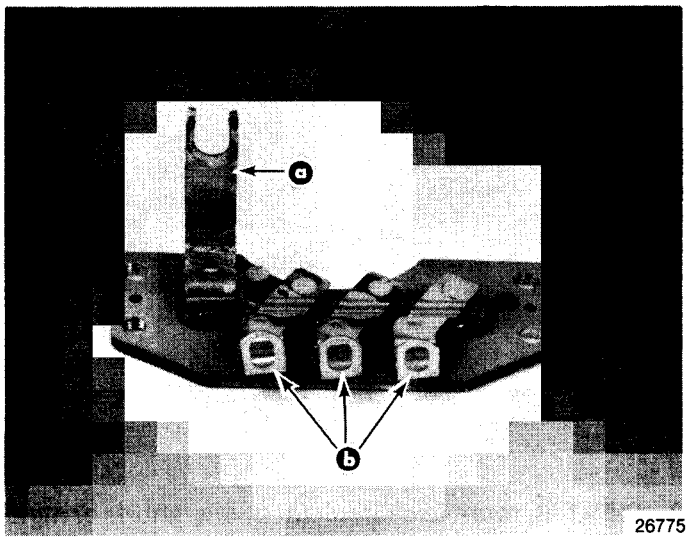
Rectifier Bridge

1. Using an ohmmeter (set on Rx1 scale), check for continuity between point (a) and each diode (b). Switch ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only, and all diodes should check alike.



26775

2. Using an ohmmeter (set on Rx1 scale), check for continuity between strap (a) and each diode (b). Switch ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only, and all diode should check alike.

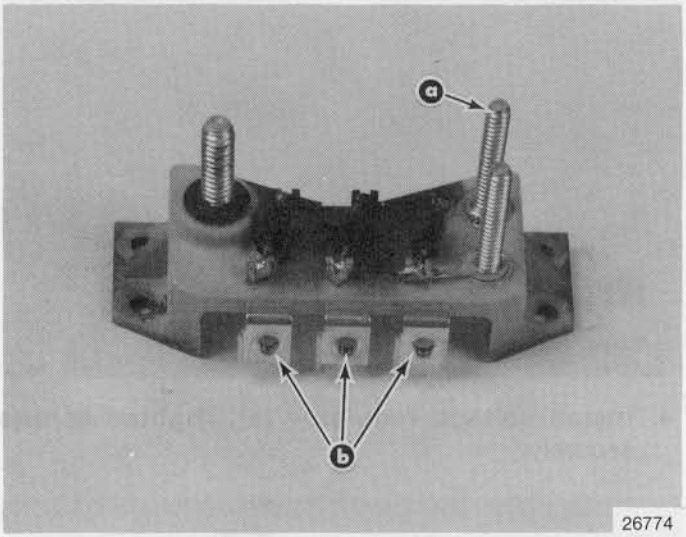


26775

If any diode is defective, replace entire rectifier bridge.

Diode Trio

1. Using an ohmmeter (set of Rx1 scale), check for continuity between stud (a) and each terminal (b). Switch ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only, and all diodes should check alike.



If any diode is defective, replace entire diode trio.

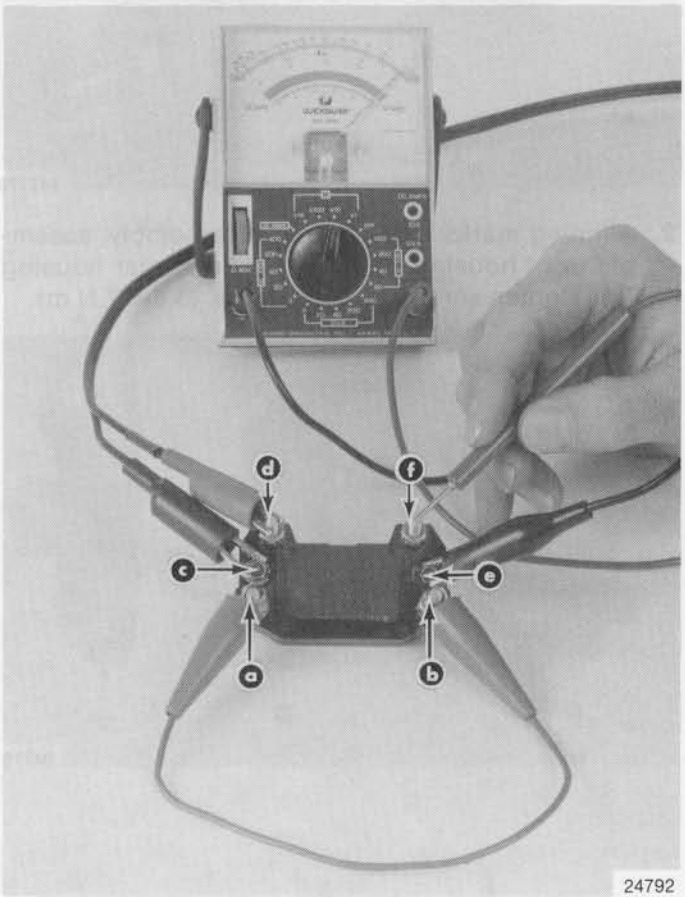
Condenser

1. Using Magneto Analyzer 91-76032 and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd)
   b. Condenser Short or Leakage Test
   c. Condenser Series Resistance Test
2. Replace condenser, if test results are not within specifications.

Voltage Regulator Test

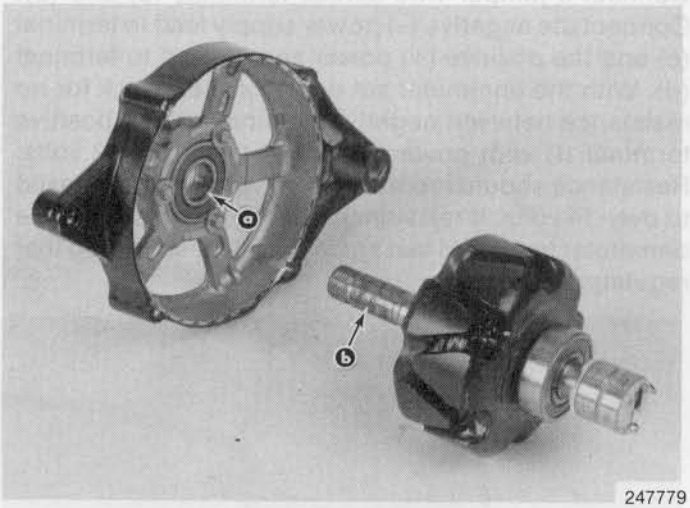
The voltage regulator can be tested using jumper wires, an ohmmeter and a variable voltage power supply (0-20 Volts DC).

Connect a jumper wire across terminals (a) and (b). Connect the negative (-) power supply lead to terminal (c) and the positive (+) power supply lead to terminal (d). With the ohmmeter set on x10 scale, check for no resistance between negative terminal (e) and positive terminal (f) with power supply at less than 12 volts. Resistance should increase when voltage is increased to over 14 volts. If resistance doesn't increase, reverse ohmmeter leads and test again before determining that regulator is defective.



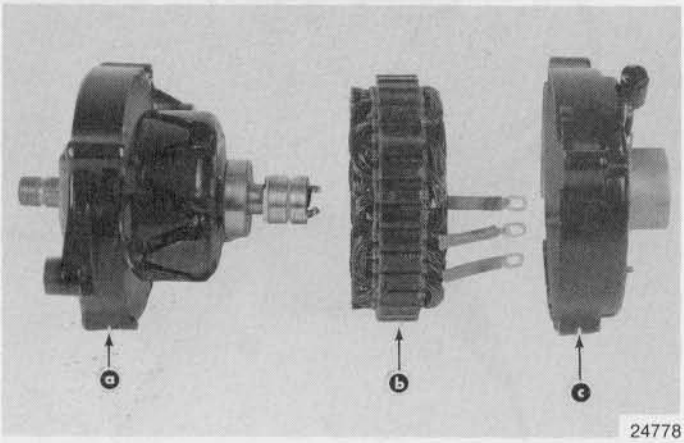
Assembly

1. Using an arbor press, install front housing with bearing (a) on rotor (b). Press only on center race of bearing until it contacts shoulder of rotor.



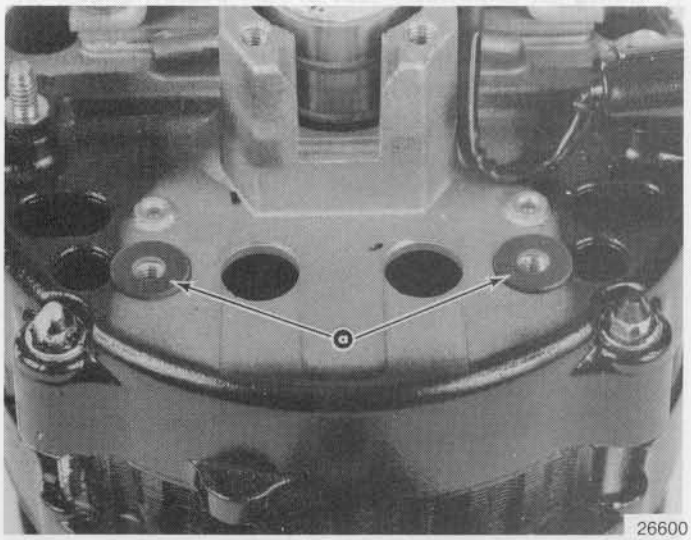
247779

2. Aligning marks made during disassembly, assemble front housing (a), stator (b) and rear housing (c). Tighten screws to 50-60 lb. in. (5.6-6.7 N.m).



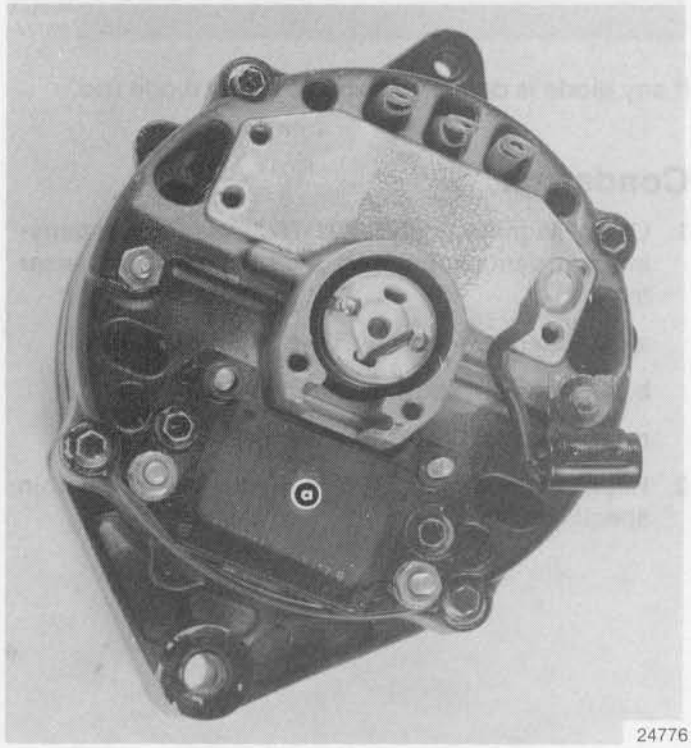
24778

3. Set fiber insulating washers (a) in place on rear housing.



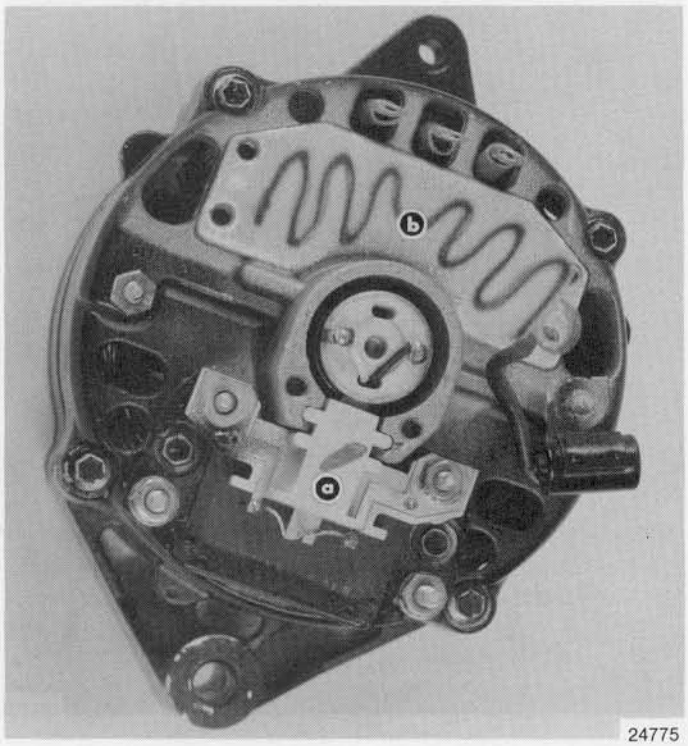
26600

4. Install voltage regulator (a). Tighten screws securely.



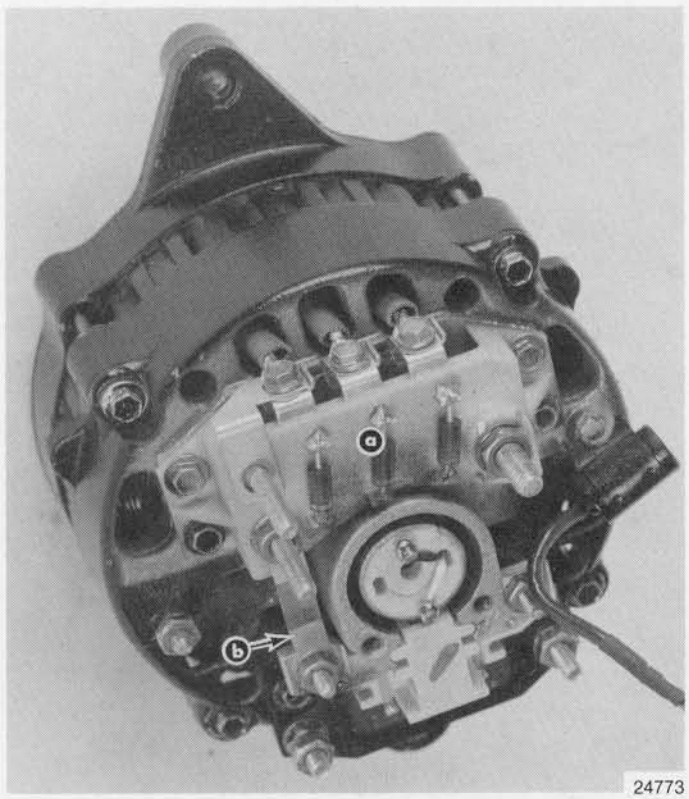
24776

5. Install brush holder (a) with only right side mounting nut finger tight. Apply a thin coating of heat sink compound to housing (b).



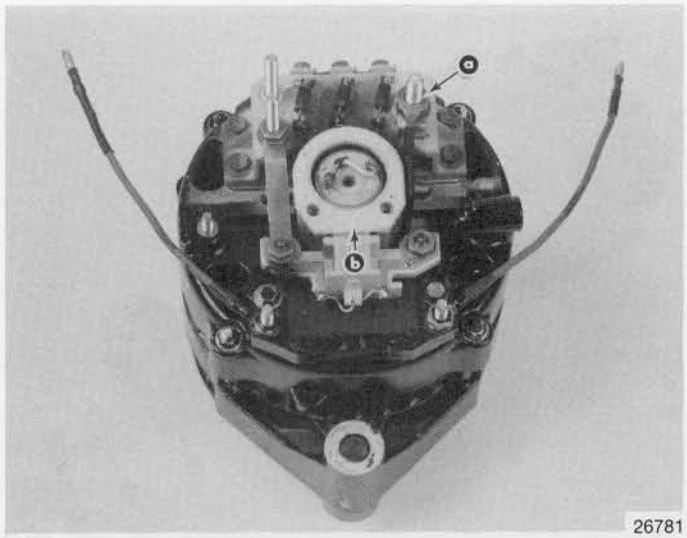
24775

6. Install diode trio/rectifier bridge assembly (a) and strap (b). Tighten mounting screws, stator screws and brush holder nuts securely.



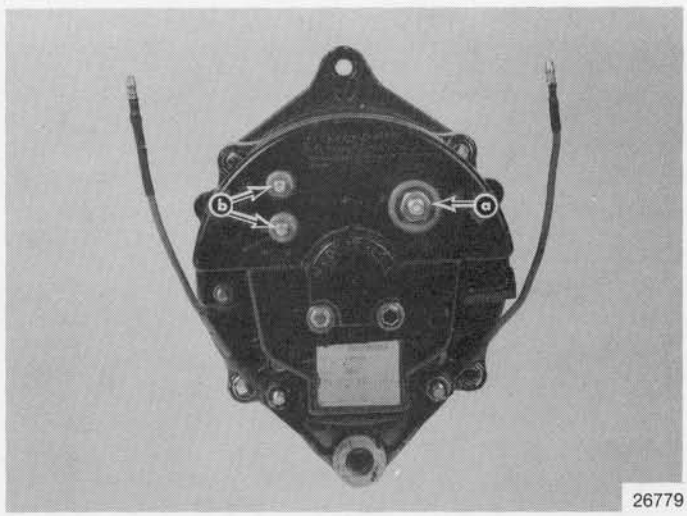
24773

7. Place condenser lead (a) on output terminal and felt gasket (b) on rear housing.



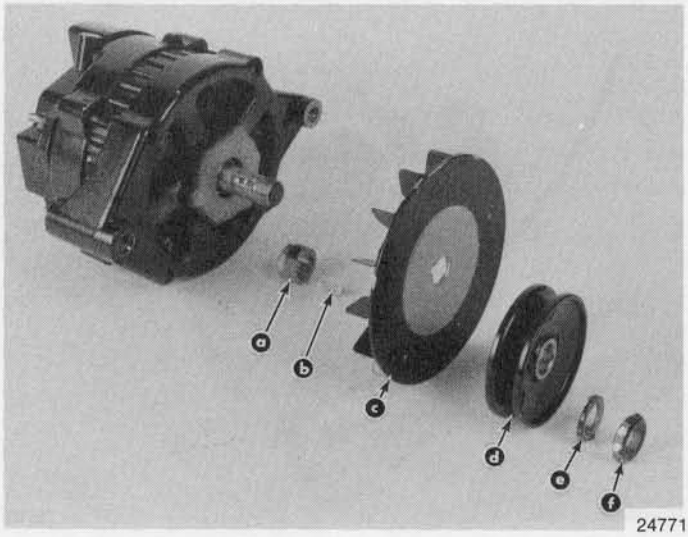
26781

8. Install cover, tighten screw securely.
9. Install insulator and nut on output terminal (a). Install nuts (b). Tighten all nuts securely.



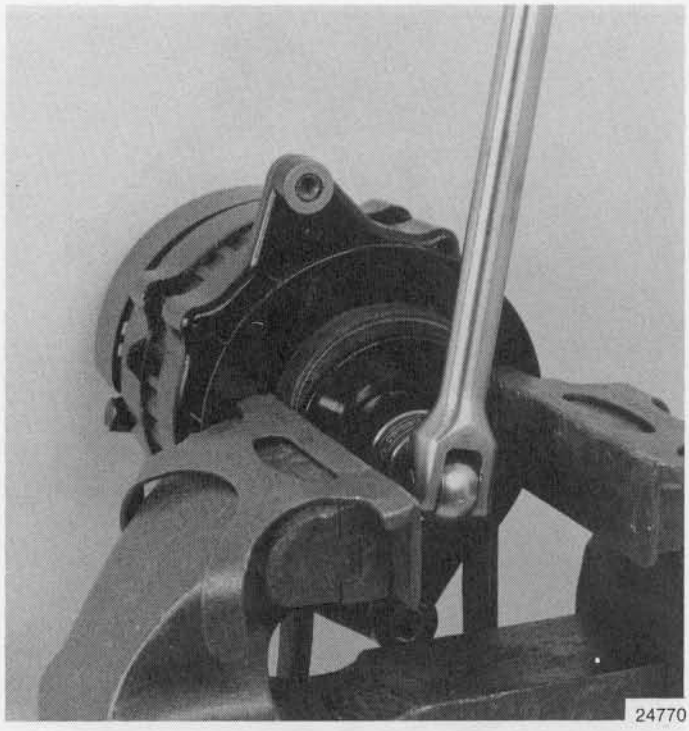
26779

10. Install spacer (a), woodruff key (b), fan (c), pulley (d), lock washer (e) and nut (f).



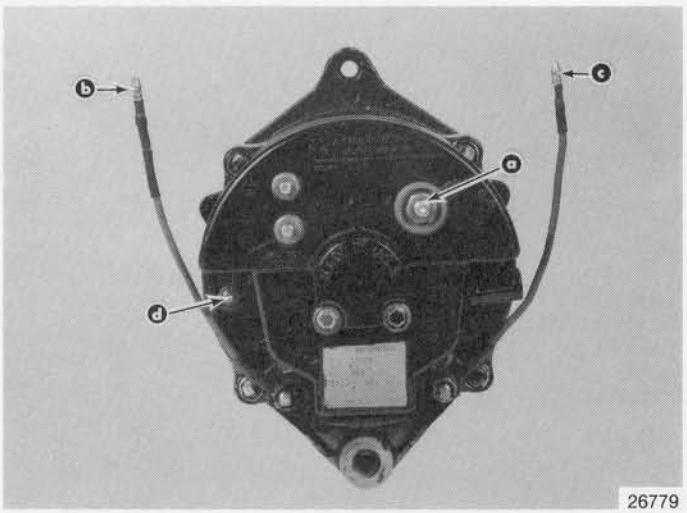
24771

11. Using an oversized belt to protect the pulley, clamp alternator in vise as shown. Tighten pulley nut to 35-50 lb. ft. (48-68 N.m).


24770

Installation

1. Install alternator on engine.
2. Install alternator belt. Tighten to specifications.
3. Tighen mounting bolts to specifications.
4. Connect alternator wires as shown.



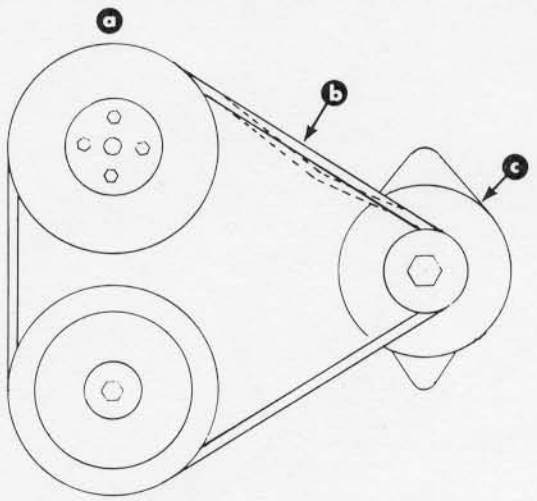
a - Orange
b - Purple
c - Red/Purple
d - Black

5. Connect battery cables to battery.

Drive Belt Replacement and Adjustment

IMPORTANT: When adjusting drive belt tension do not apply pressure to alternator rear end frame, as alternator may be damaged.

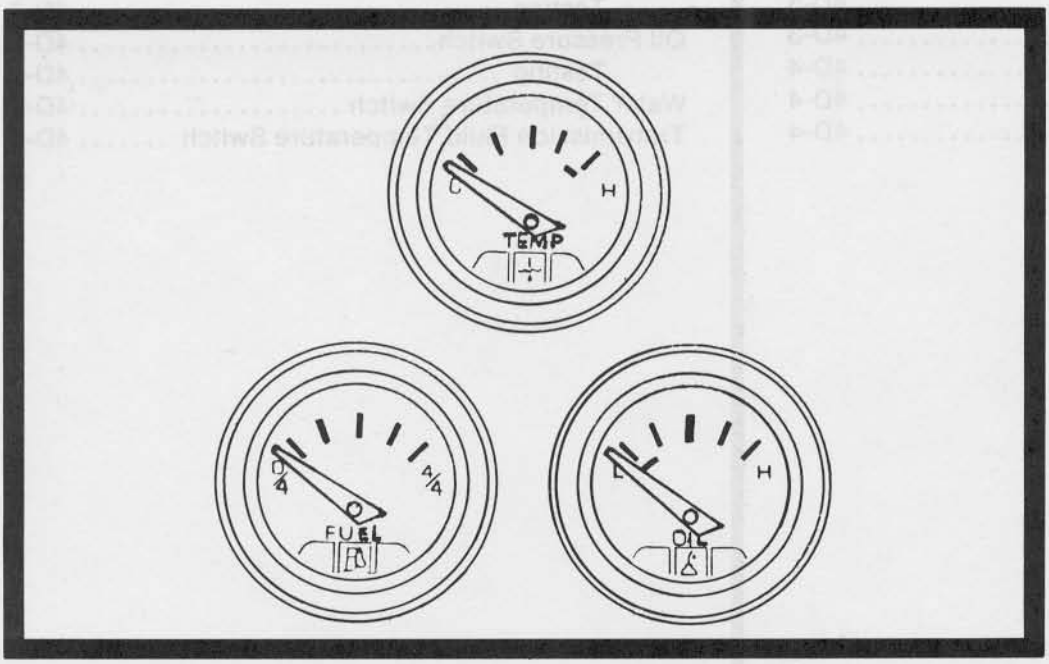
1. Check belt tension by depressing belt with thumb at midway point. Belt should depress 1/2 in. (13mm).



a - Circulating Pump Pulley
b - Check Point
c - Alternator

2. If adjustment or replacement is necessary, loosen alternator brace attaching bolts and alternator mounting bolt.
3. Pivot alternator inward to replace drive belt.
4. Pivot alternator outward, as required, to obtain correct belt tension. Apply pressure to alternator front end frame only. Set new belts at high reading.
5. Retighten alternator brace attaching bolts and alternator mounting bolt securely.
6. Recheck drive belt tension.

ELECTRICAL SYSTEM



4

D

INSTRUMENTATION

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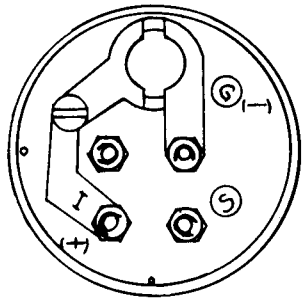
Gauges

Oil, Fuel and Temperature

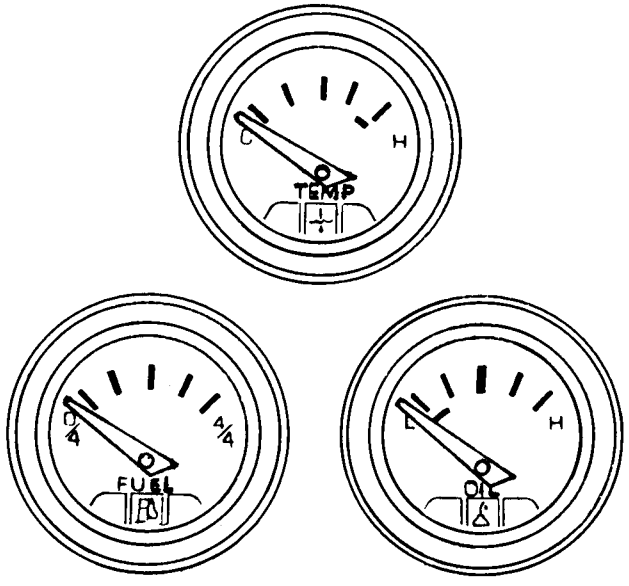
IMPORTANT: If testing proves gauge to be defective, it must be replaced as there is no repair available.

TESTING

1. Turn ignition switch "Off".
2. Remove wire from terminal "S".

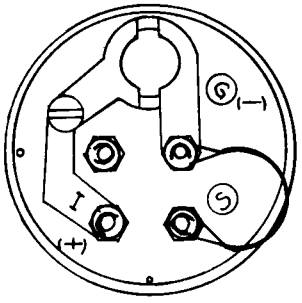


3. Turn ignition switch to "Run". Gauges must be at "A" position.

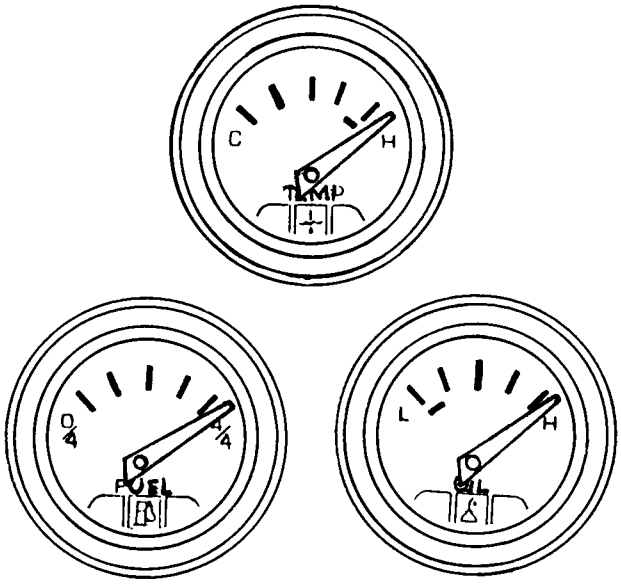


POSITION -A-

4. Turn ignition switch "Off".
5. Connect jumper wire from terminal "G" to terminal "S".



6. Turn ignition switch to "Run".
7. Indicator needle must read at "B". If not, replace gauge.

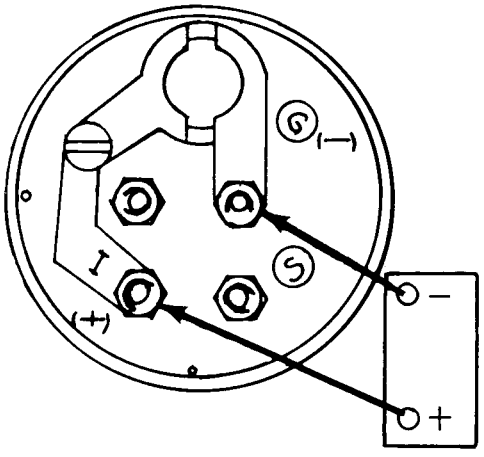


POSITION -B-

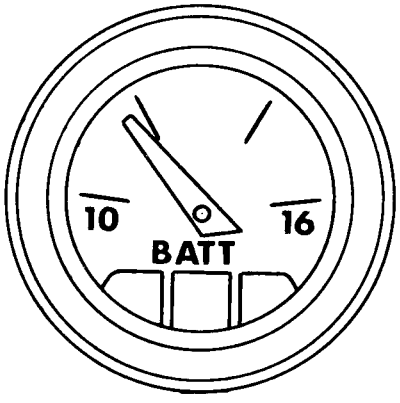
Battery Gauge

TESTING

1. Remove cables from battery and fully charge battery.
2. Connect negative (-) jumper lead from battery to gauge terminal "G".
3. Connect positive (+) jumper lead from battery to gauge terminal "I".



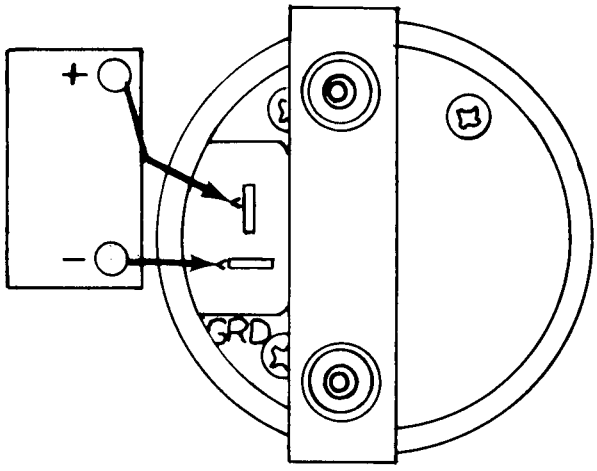
4. Check gauge reading, if not as shown replace gauge.



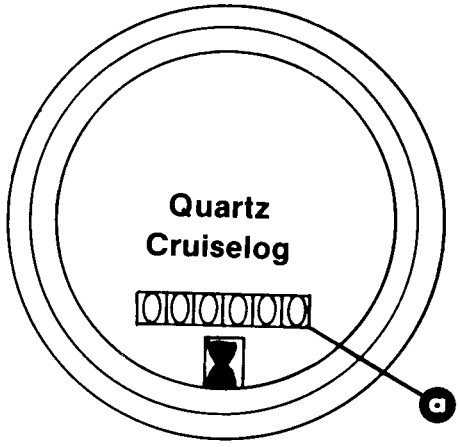
Cruiselog Meter

TESTING

1. Connect jumper wire from negative (-) battery terminal to negative (-) gauge terminal.
2. Connect jumper wire from positive (+) batttery terminal to positive (+) gauge terminal.



3. Observe gauge run indicator, if it is turning gauge is operable, if not replace gauge.



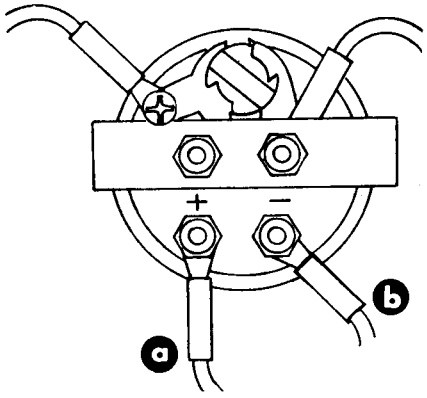
a - Run Indicator

Ammeter Gauge

TESTING

1. Disconnect battery cables at battery.
2. Connect positive (+) lead of service ammeter to orange wire, and negative (-) lead to red/purple.

IMPORTANT: Do not allow wires to come in contact with metal or other wires.



a - Positive (Orange)
b - Negative (Red/Purple)

4. Connect battery cables to battery. Ground engine high tension coil wire to engine block. Crank engine over approximately 10 seconds (to remove battery surface charge), then reconnect coil wire, start engine and run at approximately 3000 RPM while observing service ammeter. Ammeter should be registering alternator output. If not, replace gauge.

Vacuum Gauge

TESTING

1. Disconnect vacuum hose from engine. Connect service vacuum gauge to engine and record engine vacuum readings at idle, 1000, 2000 and 3000 RPM. Reconnect vacuum hose and compare vacuum gauge readings (at specified RPM) with service gauge readings. Readings should be within 3 inches of vacuum of each other.

IMPORTANT: Make sure that vacuum hose between gauge and engine is not leaking and that all connections are tight.

Speedometer

TESTING

IMPORTANT: When testing speedometer gauge for accuracy, air pressure that is used for test must be regulated to specified PSI. Do not apply excessive air pressure to speedometer gauge.

1. Apply air pressure directly to speedometer gauge (specified in chart) and note gauge reading. Light tapping of pressure gauge is required during accuracy check.
2. If gauge readings are not within specifications, gauge is defective.

CALIBRATION CHART

Air Pressure Gauge PSI	Speedometer Gauge MPH
5.3	20 ± 2 (32km/hr ± 1.6)
27.8	45 ± 1 (72km/hr ± 1.6)

Tachometer

TESTING

1. Connect a service tachometer to engine and compare readings.
2. Replace if not within specifications.

TACHOMETER TYPE	ALLOWABLE RANGE
6000 RPM	± 150 RPM
8000 RPM	± 200 RPM

Gauge Replacement

1. Disconnect battery cables from battery.
2. Remove wires from back of gauge.
3. Remove hose (vacuum, speedometer gauge).
4. Disconnect light socket.
5. Remove holding strap and remove gauge.
6. Position gauge assembly in appropriate mounting hole.
7. Install holding strap and nuts. Tighten nuts evenly and securely.

IMPORTANT: Do not distort case or bracket by overtightening.

8. Connect ground (black) wire to ground terminal, if gauge is not mounted in metal panel.

9. Connect other wires to gauge as shown in "Section 3, Part F".
10. Connect hoses (vacuum, speedometer gauges).
11. Install gauge light socket.
12. Coat all terminals with Liquid Neoprene.
13. Reconnect battery cables to battery.

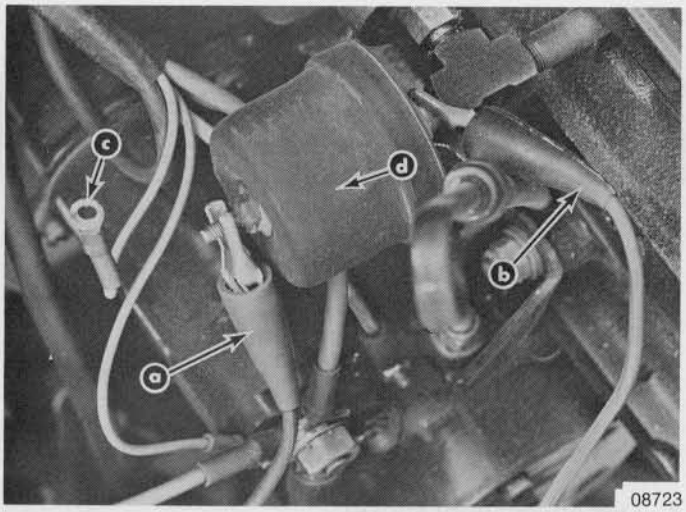
Senders

Oil Pressure

TESTING

IMPORTANT: Use following test procedure for checking accuracy of oil pressure sender only. If oil pressure gauge indicates zero oil pressure, refer to "Troubleshooting" section.

1. Remove wire from sender terminal.
2. Connect ohmmeter between sender terminal and sender case. Check ohms reading without engine running (zero pressure), then check reading with engine running. Compare oil pressure and ohms readings as shown in following chart:



08723

a - Positive Lead
b - Negative Lead
c - Wire Removed
d - Oil Pressure Sender

Oil Pressure (Lbs./Sq. In.)	Ohms Reading	
	Single	Dual
0	227-257	113.5-128.5
20	142-162.5	71-81.25
40	91.7-113.6	45.8-56.8
80	9-49	4.5-24.5

Dual Station Sender Identification

Sender will have 353-AM stamped on hex of sender.

Water Temperature

There is no test for sender, install new sender.

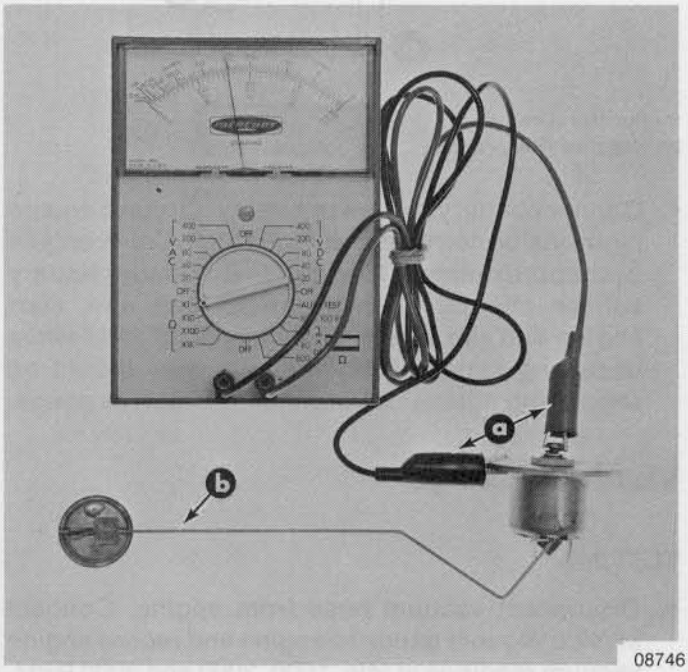
Dual Station Sender identification sender will have 362-BC stamped on hex.

Fuel Tank Sender

FLANGE TYPE

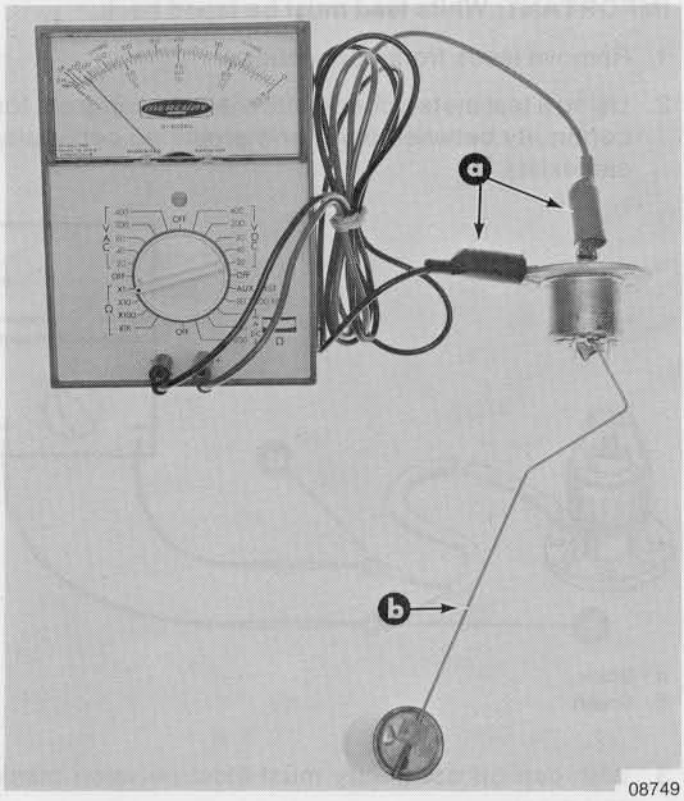
Testing

1. Disconnect wire from terminal on sending unit and ground wire from sending unit mounting screw.
2. Remove sending unit from fuel tank.
3. Connect ohms meter between sending unit terminal and sending unit housing.
4. With float arm in "full" position (arm horizontal), ohmmeter should read 30 ohms (± 5 ohms).



08746

5. With float arm in "empty" position (arm vertical) meter should read 240 ohms (± 5 ohms). Sender is defective if not within specifications.



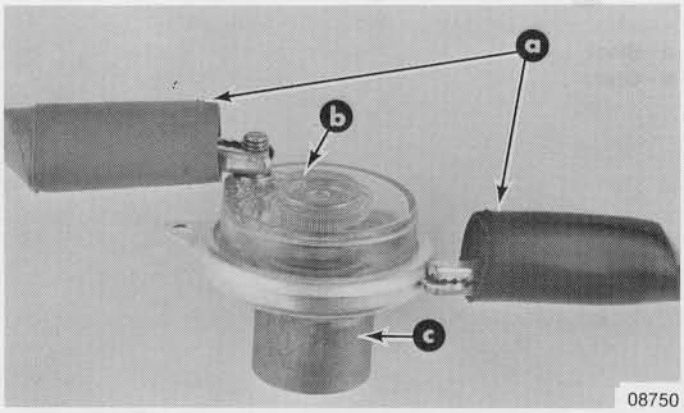
08749

a - Ohmmeter Leads
b - Vertical Float Arm

CAPSULE TYPE

Testing

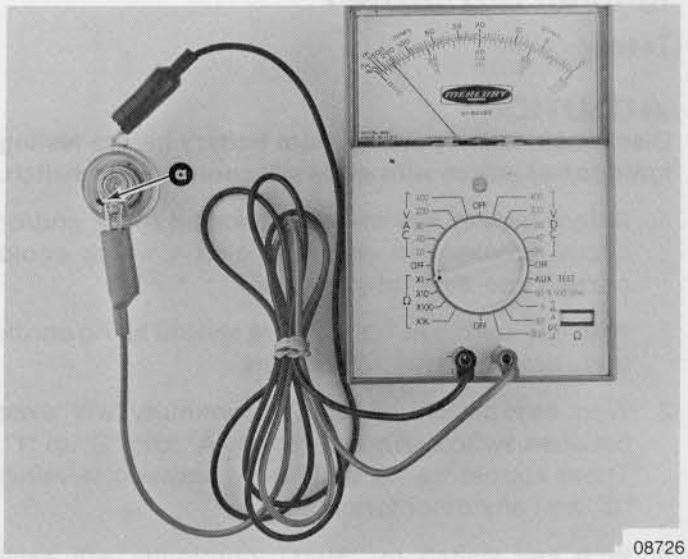
1. Disconnect wire from terminal on fuel tank capsule.
2. Remove 2 screws and remove capsule assembly.
3. Place a magnet under fuel capsule.
4. Connect ohmmeter between fuel capsule terminal and metal portion of capsule housing.



08750

a - Ohmmeter Leads
b - Capsule Assembly
c - Magnet

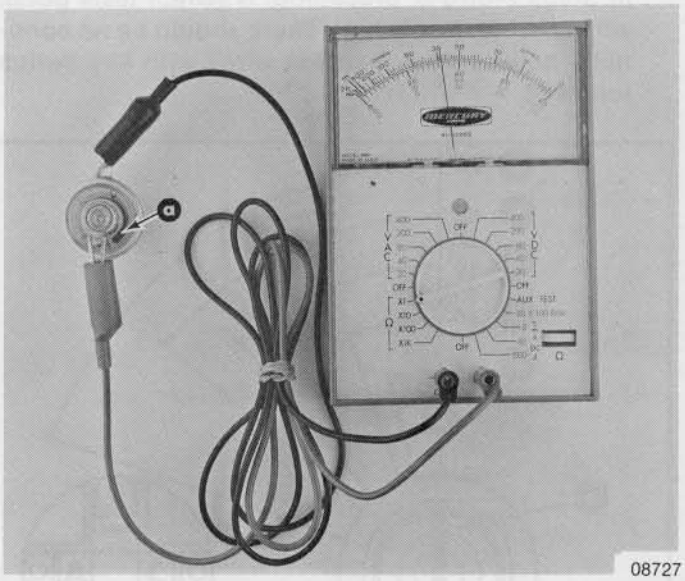
5. Turn magnet counterclockwise until fuel capsule indicator reads empty. Ohmmeter should read 240 ohms (± 5 ohms).



08726

a - Capsule Reading Empty

6. Turn magnet clockwise until fuel capsule indicator reads "Full". Ohmmeter should read 30 ohms (± 5 ohms). Fuel capsule is defective if not within specifications.



08727

a - Capsule Reading Full

Switches

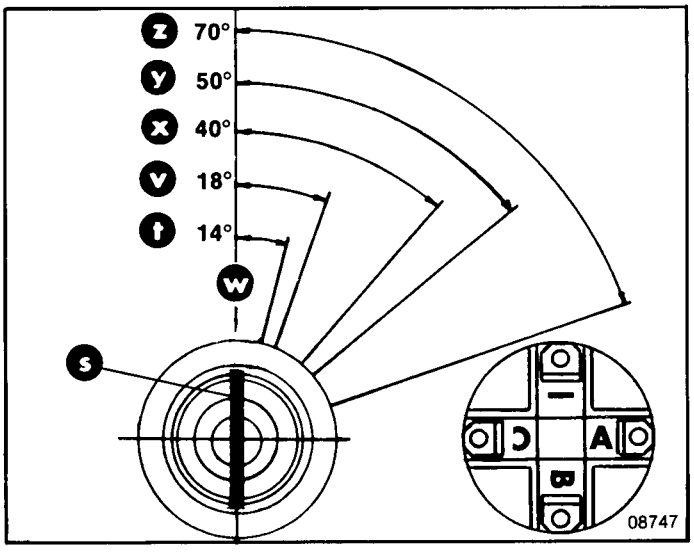
Ignition Key Switch

Testing

⚠CAUTION

Disconnect battery cables from battery before testing ignition key switch with wires still connected to switch.

1. Before testing key switch, check all fuses and/or circuit breakers in electrical circuit which could prevent operation of starter.
2. With key switch in "Off", there should be no continuity between switch terminals.
3. With key switch in "Run", continuity will exist between switch terminal "B" to "A" and "B" to "I". There should be no continuity between terminal "C" and any other terminals.
4. With key switch in "Start", continuity will exist between terminal "B" to "A", "B" to "I" and "B" to "C".
5. Terminals are to make contact at angles shown and to stay in contact condition as switch is rotated toward "Start".
6. If ignition key switch tests bad, unsolder wire connections and remove switch. Test switch again, as in Steps 2-thru-5, preceding. If switch tests good, wiring in harness is bad. There should be no continuity between any harness wires with key switch removed.



KEY VIEW BACK VIEW

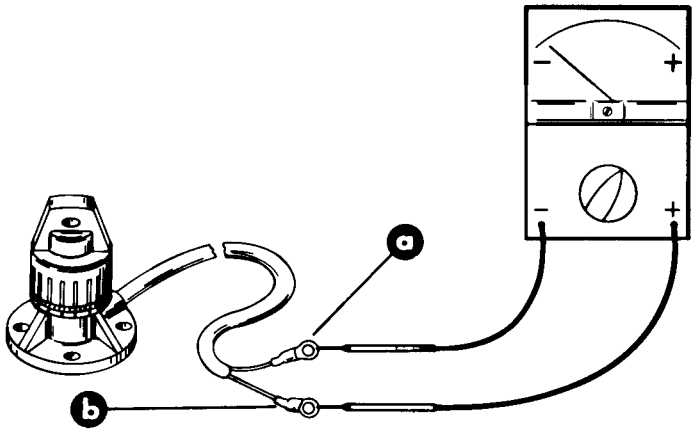
S - Key
W - Off
T - Continuity, B-A Terminals
V - Continuity, B-I Terminals
X - Run
Y - Continuity, B-C Terminals
Z - Start

Emergency Stop Switch

TESTING

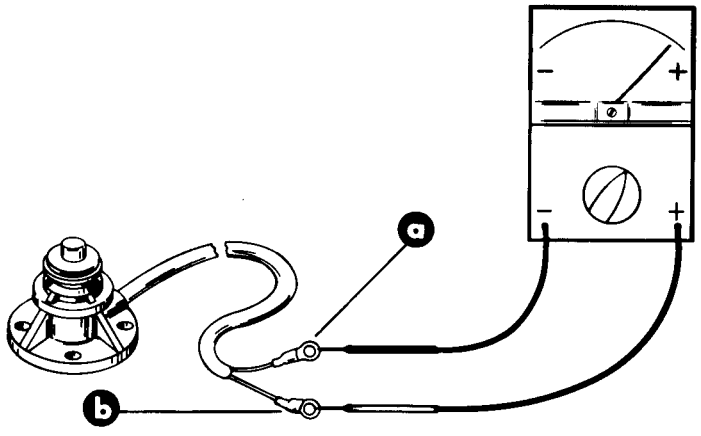
IMPORTANT: White lead must be taped back.

1. Remove leads from connections.
2. Using a test meter, check with the switch cap on, for continuity between black and green, no continuity can exists.



a - Black
b - Green

3. With cap off continuity must exist between black and green.



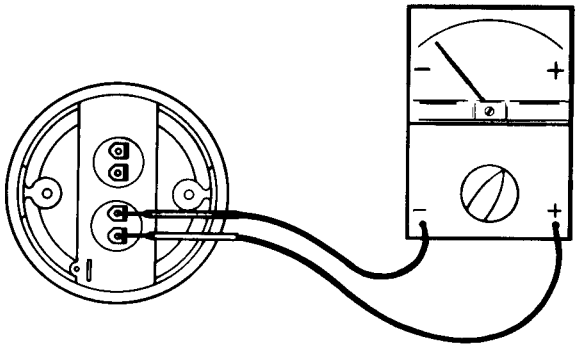
a - Black
b - Green

Start/Stop Switch

TESTING

⚠WARNING
Disconnect battery leads at battery before testing.

1. Disconnect battery leads.
2. Check for continuity between the terminals on the start switch with a continuity meter.



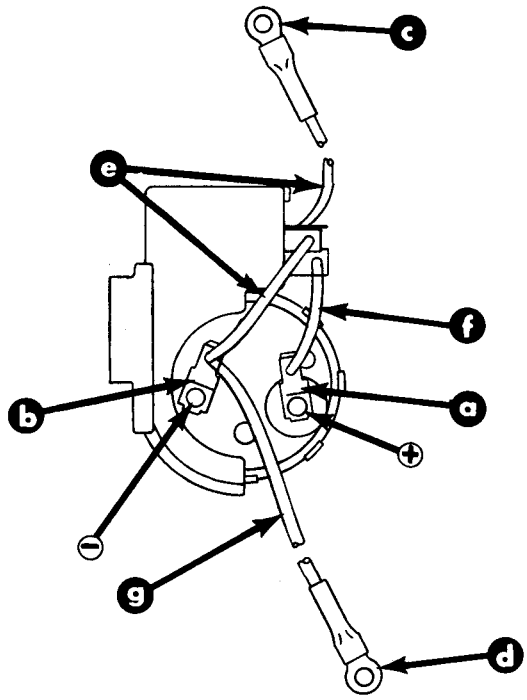
3. No continuity should exist.
4. Depress switch button and continuity should exist.
5. Check stop switch in the same manner.
6. If continuity exists when in the open (not depressed) state, replace panel button.

Audio Warning System

Horn and Timer

TESTING

1. Turn key to "Run" position (engine off).
2. Wait 7 to 14 seconds for horn to sound.
3. If horn does not sound:
   a. Connect jumper wires as shown.
   b. If horn does not sound, replace it.
4. If horn worked in step 3:
   a. Connect jumper wires as shown.
   b. Repeat step 2.
   c. If horn sounds, problem is in tan/blue wire back to engine or switches on engine.

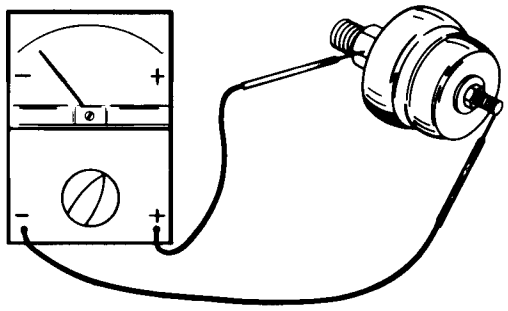


a - Jumper Wire to 12-V (+) ┐
b - Jumper Wire to Ground (-) ┘ STEP 3
c - Jumper Wire to 12-V (+) ┐
d - Jumper Wire to Ground (-) ┘ STEP 4
e - Purple Wire
f - Red Wire
g - Tan/Blue Wire

Oil Pressure Switch

TESTING

1. Remove wire from sender terminal.
2. Connect continuity meter between sender terminal and sender hex.



3. With engine not running, meter should indicate full continuity.
4. Start engine. With engine running and engine oil pressure above 6 PSI (41 kPa), meter should indicate NO continuity.

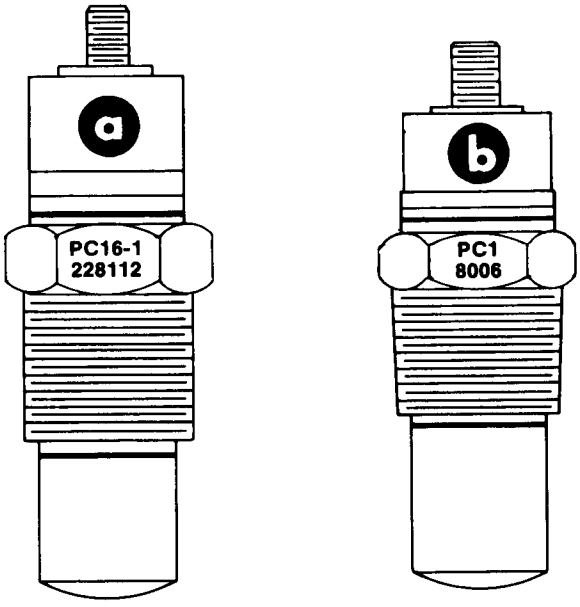
SWITCH IDENTIFICATION

Switch has 364-AF stamped on hex of sender.

Water Temperature Switch

Switch is normally open.

Switch Identification



a - 48952 Switch with Red Mylar Sleeve
b - 87-86080 Switch with Black Mylar Sleeve

48952 SWITCH	
Opens	150° F - 170° F (66° C - 77° C)
Closes	190° - 200° F (88° C - 93° C)

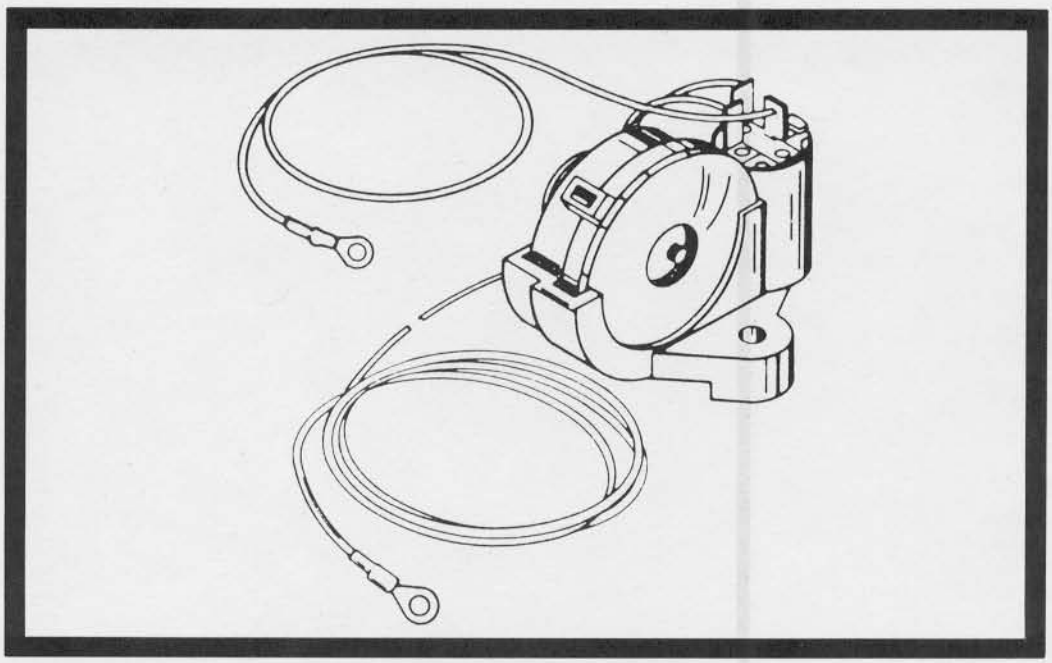
87-86080 SWITCH	
Opens	175° F - 195° F (79° C - 91° C)
Closes	215° - 225° F (102° C - 107° C)

Transmission Fluid Temperature Switch

Switch is located on transmision. Switch is normally open. this switch is used on MCM 330 (B-W) and MIE 230/260/340 engines.

87-88031 SWITCH	
Opens	180° F - 200° F (82° C - 93° C)
Closes	220° - 240° F (104° C - 116° C)

ELECTRICAL SYSTEM



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E

ELECTRICAL KITS

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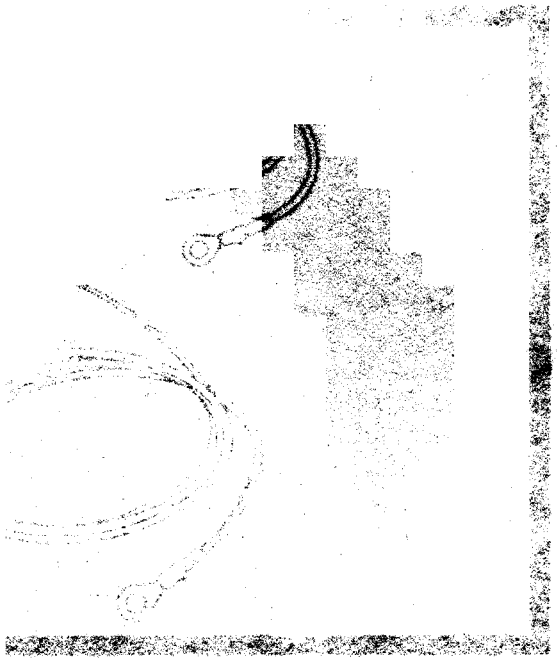
MCM 200 Wiring Harness Kit 84-98423A4	4E-8
Wiring Harness Kit 84-86683A2 MCM 330, 370, 400, 440, 460	4E-9

Wiring color code for MerCruiser

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK

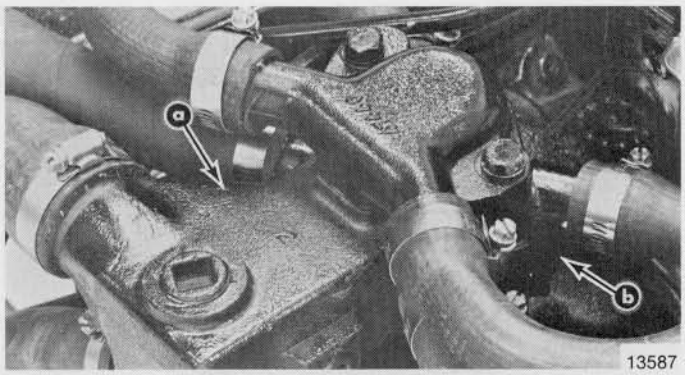


Audio Warning System Kit 86047A3

FOR MCM 300MR, 370, MIE 440

INSTALLING WATER HEAT SWITCH ON V-8 ENGINES with STANDARD COOLING

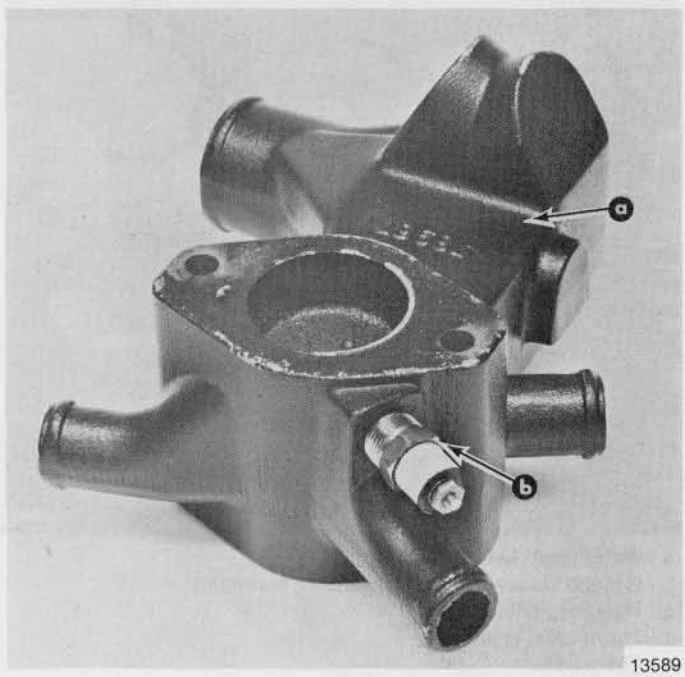
1. Drain cooling system.
2. Disconnect hoses from thermostat housing.
3. Remove thermostat housing from engine and scrape gasket material from all mating surfces.



13587

a - Thermostat Housing
b - Pipe Plug (on Aft Side of Thermostat Housing; Hidden)

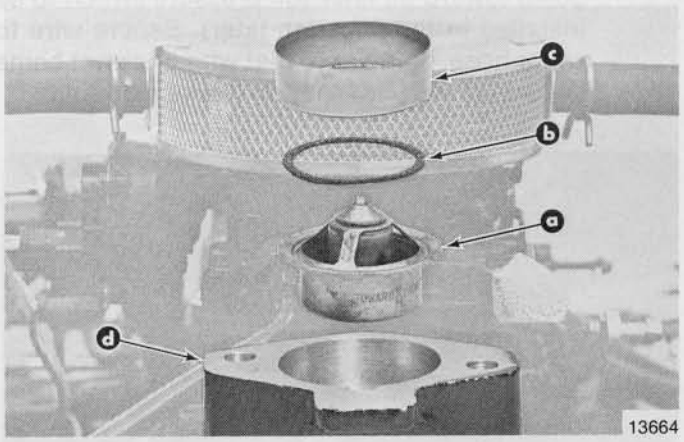
4. Install water heat switch as follows:
   (1) Install water heat switch into aft side of thermostat housing, using teflon tape to seal threads. Tighten water heat switch securely.



13589

a - Thermostat Housing
b - Water Heat Switch

(2) Install thermostat housing, new gasket with continuity rivets and thermostat and components as shown. Torque screws to 30 lbs. ft. (41 N.m).

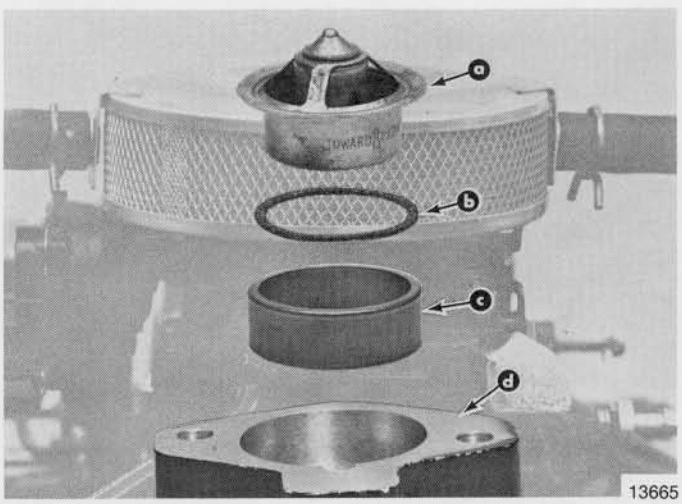


13664

a - Thermostat
b - Cork Gasket
c - Sleeve (Turned in Lip, Down)
d - Thermostat Housing

Normal Thermostat Assembly

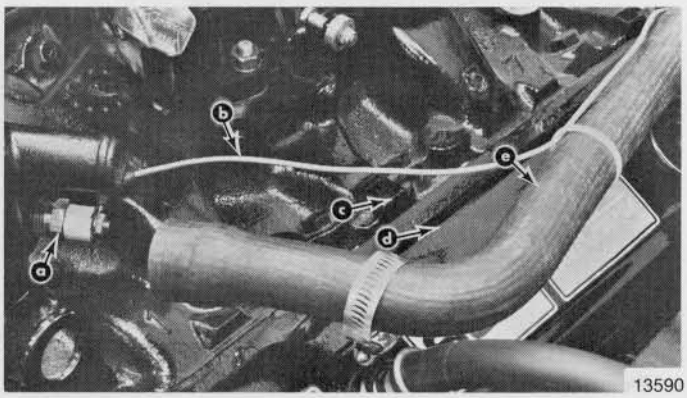
IMPORTANT: Check water heat switch to ensure that switch does not interfere with thermostat. If interference does exist, thermostat and related parts must be rearranged as shown.



13665

a - Thermostat
b - Cork Gasket
c - Sleeve (Turned in Lip, Up)
d - Thermostat Housing

(3) Attach 3 ft. (914mm) tan/light blue wire (from kit) to heat switch with nut and lockwasher. Route wire along port rocker arm cover and down toward oil filter (oil pressure switch to be installed in this location later). Seucre wire to water hose, being sure that wire does not come in contact with hot spot on intake manifold.



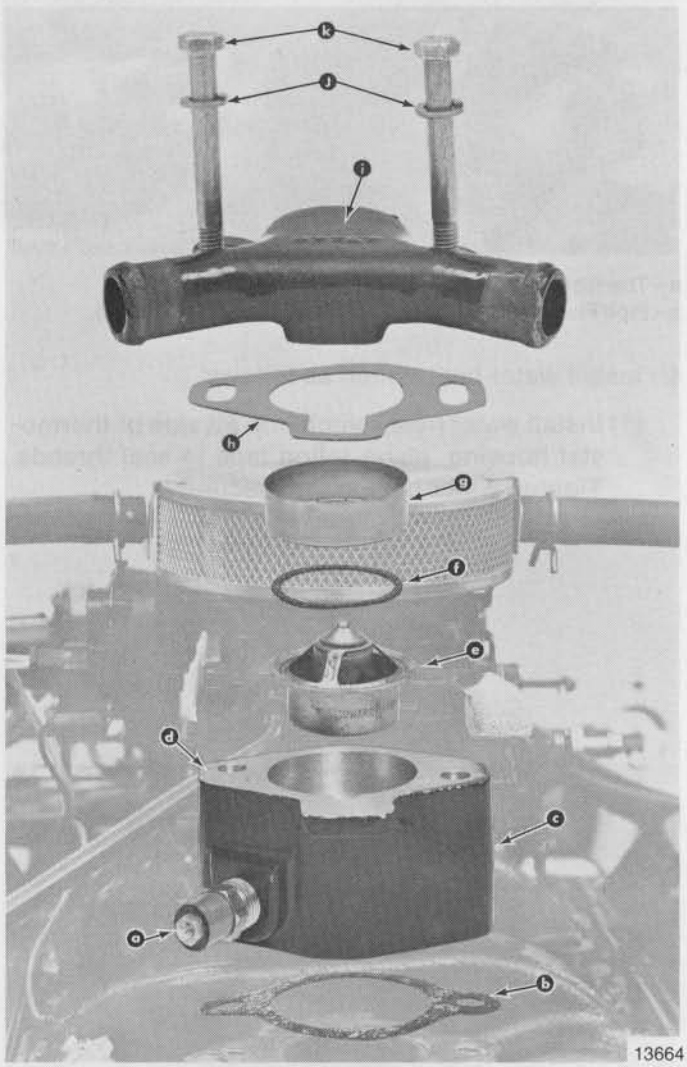
13590

a - Water Heat Switch
b - Tan/Light Blue Wire (Route and Fasten as Shown)
c - Intake Manifold Hot Spot
d - Port Rocker Arm Cover
e - Secure Wire to This Water Hose

(4) Reconnect water hoses (removed in Step 2) to their respective locations.

INSTALLING WATER HEAT SWITCH on V-8 ENGINES with CLOSED COOLING

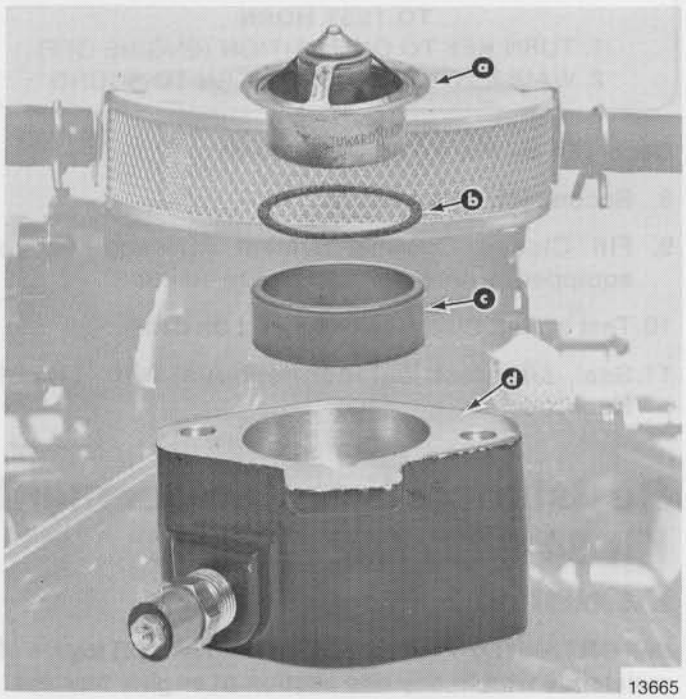
1. Drain cooling system.
2. Remove thermostat housing and cover, then scrape gasket material from all mating surfaces.
3. Remove pipe plug from front of thermostat housing and install water heat switch in its place, using teflon tape to seal threads. Tighten heat switch securely.
4. Install thermostat and related parts in sequence shown.
5. Install thermostat housing and cover, using gasket (with continuity rivets) from kit and new thermostat cover gasket. Use Perfect Seal on gasket cover before installing. Torque bolts to 30 lbs. ft. (41 N.m).



13664

a - Water Heat Switch
b - Ground Gasket (Housing to Intake Manifold)
c - Pipe Plug (Hidden)
d - Thermostat Housing
e - Thermostat
f - Cork Gasket (Thermostat to Sleeve)
g - Sleeve (Turned in Lip Down)
h - Gasket (Thermostat Housing to Cover)
i - Thermostat Housing Cover
j - Lockwashers
k - Bolts

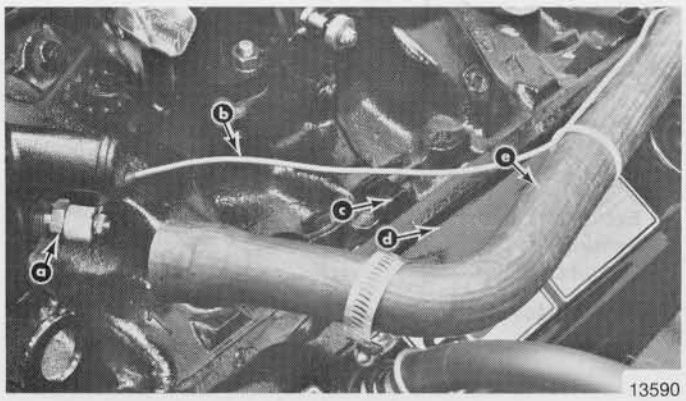
IMPORTANT: Check water heat switch to ensure that heat switch does not interfer with thermostat. If interference does exist, thermostat and related parts must be rearranged as shown.



a - Thermostat
b - Cork Gasket
c - Sleeve (Turned in Lip Up)
d - Thermostat Housing

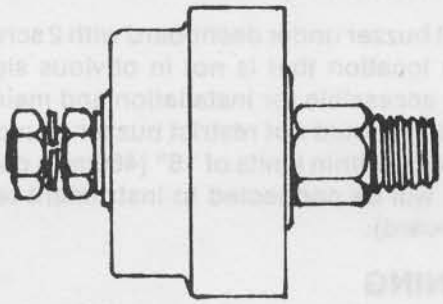
Thermostat and Related Parts Rearranged if Heat Switch Interferes with Thermostat

6. Attach 3 ft. (914mm) tan/light blue wire (from kit) to switch with nut and lockwasher.
7. Route wire to and along port rocker arm cover and down toward oil filter (oil pressure switch to be installed in this location later). Secure wire to water hose, being sure that wire does not come in contact with hot spot on intake manifold.



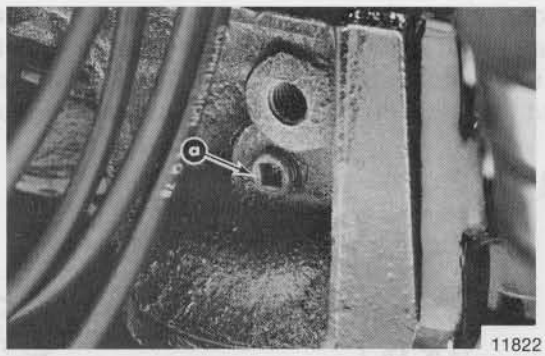
a - Water Heat Switch
b - Tan/Light Blue Wire (Route and Fasten as Shown)
c - Intake Manifold Hot Spot
d - Port Rocker Arm Cover
e - Secure Wire to This Water Hose

Installing Oil Pressure Switch



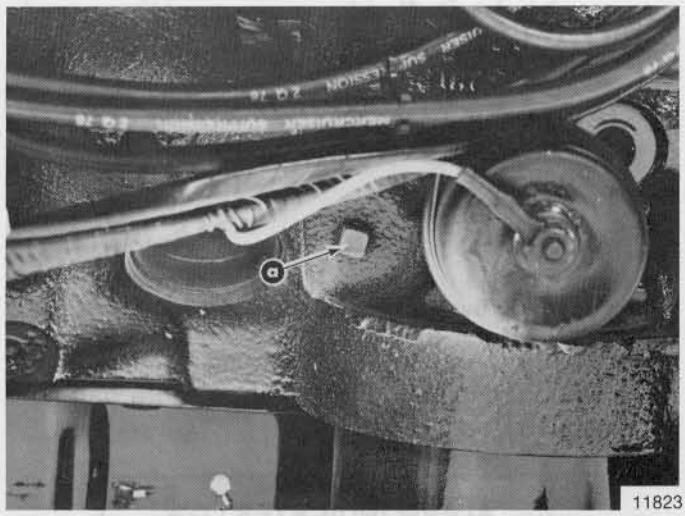
Oil Pressure Switch

1. Remove oil plug from location shown.
2. On big block V-8's, install oil pressure switch in place of plug. On small block V-8's, install reducer (from kit) and oil pressure switch in place of plug. Use teflon tape to seal threads and tighten fittings securely.
3. Connect wire from heat switch to oil pressure switch with lockwasher and nut. Torque nut to 15 lbs. in. (1.7 N.m).



a - Oil Plug

Oil Plug Location on Small Block V-8 Engines



a - Oil Plug

Oil Plug Location on Big Block V-8 Engines

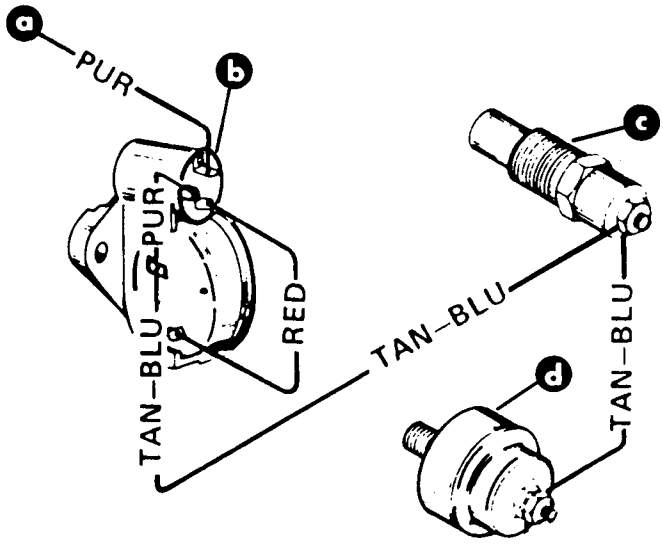
Installing Warning Buzzer

1. Disconnect battery leads.
2. Mount buzzer under dashboard with 2 screws (from kit) in location that is not in obvious sight but is easily accessible for installation and maintenance. Location should not restrict buzzer sound and also should be within limits of 18" (460mm) purple lead. (Lead will be connected to instrument terminal in dashboard).

⚠WARNING

Buzzer is not external ignition-proof, therefore, do not mount buzzer in engine or fuel tank compartments.

3. Attach purple lead to "+ 12V" switched terminal of any adjacent gauge [purple to purple (BIA)]. The attaching terminal should be "off" when ignition switch is in "Off" position.
4. Route tan/light blue wire from buzzer back to engine compartment, supporting wire every 18". Be sure that wire does not chafe or get pinched and does not come in contact with bilge water or moving parts.
5. Connect tan/light blue lead from buzzer to engine water heat switch or oil pressure switch, whichever is more accessible with lockwasher and nut. Torque nut to 15 lbs. in. (1.7 N.m). (Do not over-tighten).



a - To 12 Volt Source
b - Audio Warning Buzzer
c - Water Temp Heat Switch
d - Oil Pressure Switch

6. Place decal on bottom of glass face of water temperature gauge and of oil pressure gauge, if equipped.

ALARM INDICATES LOW OIL OR OVERHEATING

Decal (To Be Placed on Face of Gauge)

7. Place decal in convenient location on dashboard.

ENGINE SENSOR HORN WILL SOUND WHEN OIL PRESSURE IS TOO LOW OR TEMP. IS TOO HOT.

TO TEST HORN

1. TURN KEY TO ON POSITION (ENGINE OFF)
2. WAIT 7 TO 14 SEC. FOR HORN TO SOUND

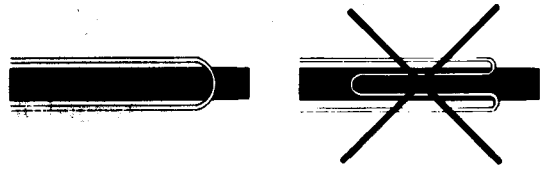
Decal (To Be Placed on Dashboard)

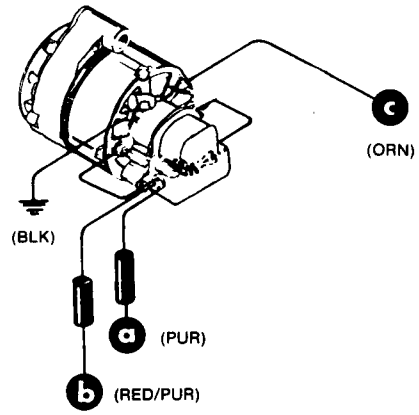
8. Reconnect battery leads.
9. Fill Closed Cooling System (on engines so equipped) with water/anti-freeze solution.
10. Test switch (horn) as explained on decal.
11. Seal all electrical connections with Liquid Neoprene.

Resistance Wire Replacement Kit 84-94227A2

Installation

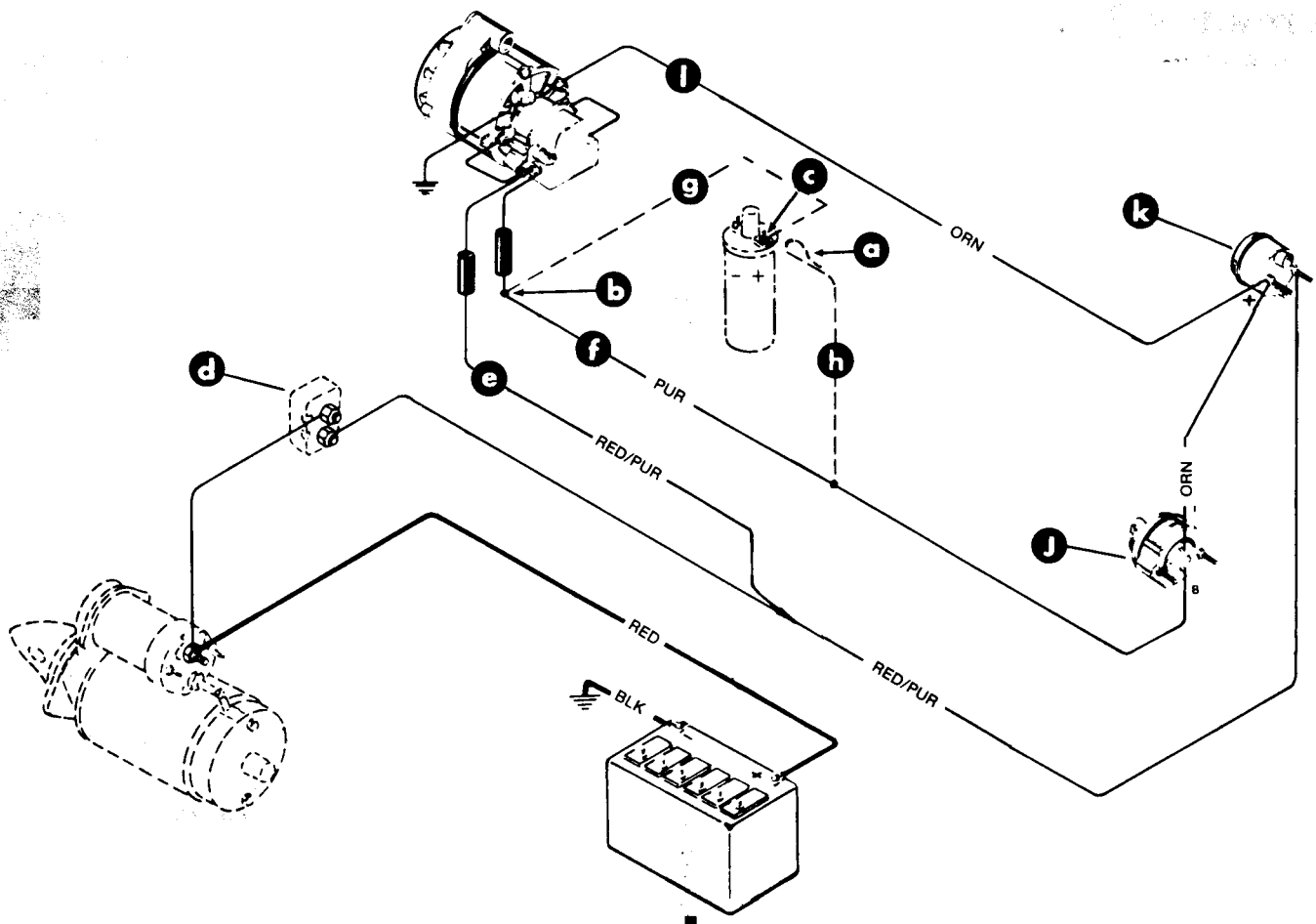
IMPORTANT: Do not tape more than two (2) layers of resistance wire in any one section of engine harness.





a - Excitation Lead
b - Sensing Lead
c - Output Lead

3-Wire Motorola or Mando Alternators



a - Disconnect Damaged White or Purple (Stainless Steel Core) Resistance Wire From Ignition Coil and Tape Back to Harness
b - Strip Outer Insulating Jacket of White or Purple (Copper Core) Wire. Wrap and Solder Copper End of NEW Resistance Wire to White or Purple Wire Insulate Junction
c - Attach Ring Terminal End of NEW Resistance Wire to Ignition Coil and Coat Connection with Quicksilver Liquid Neoprene
d - Circuit Breaker
e - Sensing Lead
f - Excitation Lead
g - New Resistance Wire
h - Old Resistance Wire
j - Ignition Switch
k - Ammeter
l - Output Lead

3-Wire Alternator System With or Without Electric Choke (Typical)

Emergency Stop Switch 65503A2

Installation

⚠WARNING
Disconnect battery leads at battery before attempting to install ignition safety stop switch.

⚠CAUTION
This stop switch is to be used as a safety stop switch only. It should not be used as the normal engine shut-off.

IMPORTANT: Emergency stop switch is supplied with a second cap to be used as a spare (to enable engine to be started, incase first cap is lost). Keep spare cap in a handy place aboard boat.

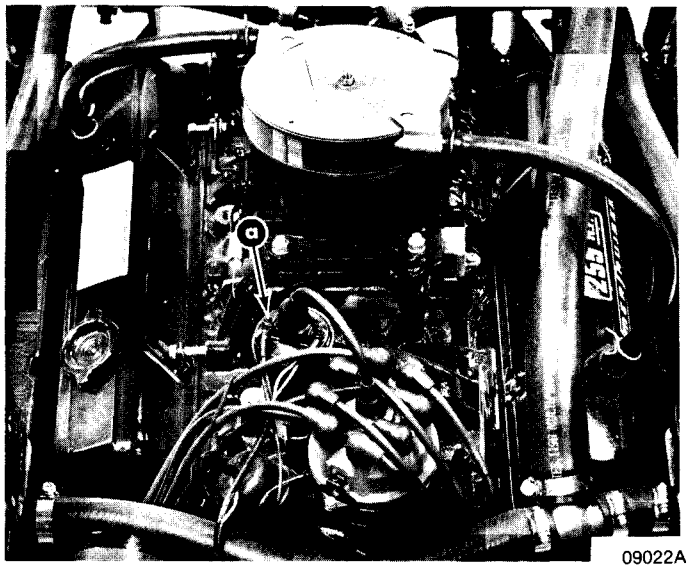
1. Route stop switch wire harness to engine so that it will not chafe or flex unnecessarily. Secure harness with sta-straps provided.
2. Check stop switch operation after installation is completed.
3. Coat all electrical connections with Liquid Neoprene after checking switch operation.
4. Attach stop switch cap to operator's person with a suitable cord (lanyard). Length of cord should be no longer than absolutely necessary and should have a minimum breaking strength of 100 lbs. (45kg).

IMPORTANT: To prevent the possibility of damage to ignition components, turn ignition switch to "Off" position as soon as possible after safety stop switch has been activated.

5. To reset stop switch after activation, simply install stop switch cap with a straight firm push.

MerCruiser Engines with Breaker Point Ignition

1. Tape white stop switch harness lead to harness and insulate with at least two layers of electrical tape.
2. Connect black stop switch harness lead to ignition coil negative (-) terminal along with existing wires.



09022A

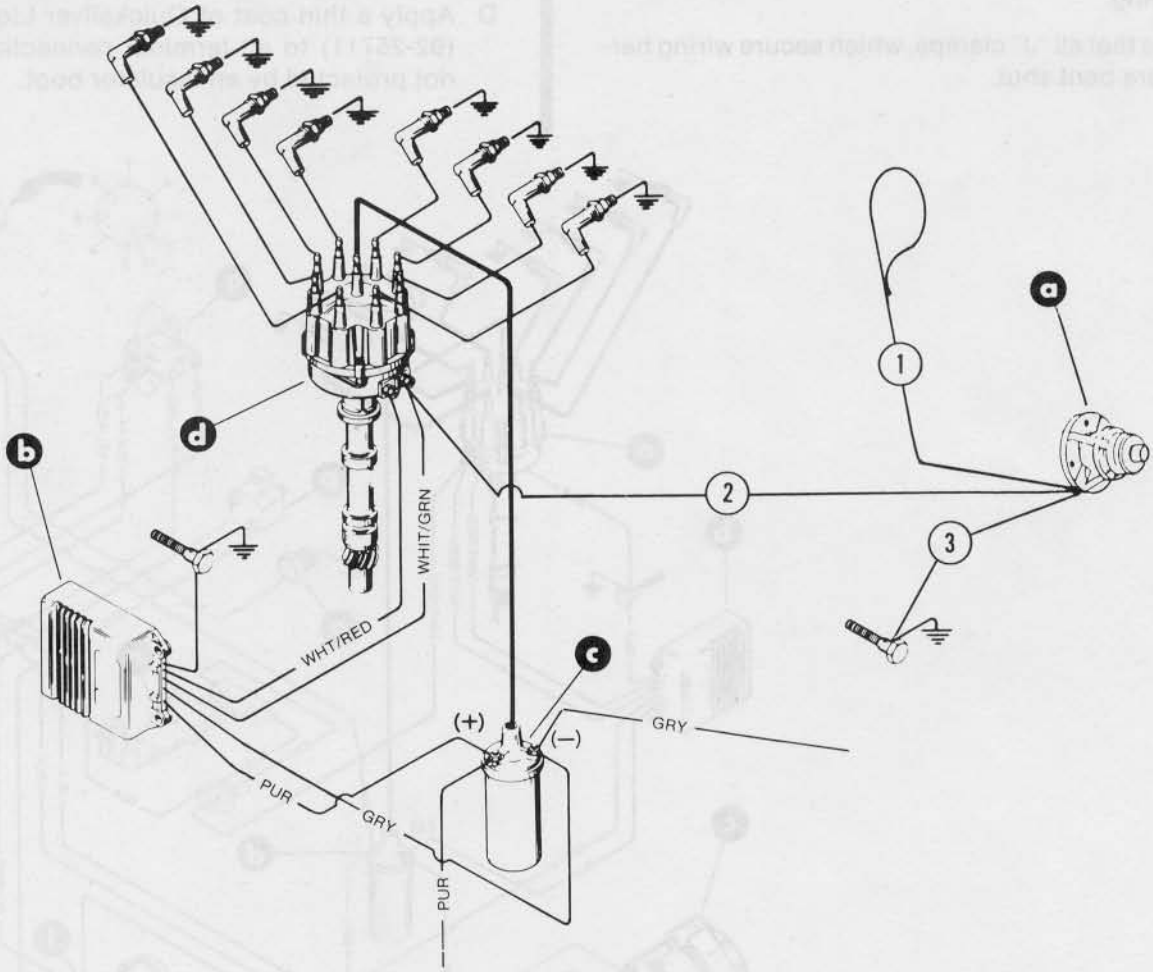
a - Negative (-) Coil Terminal

Wire Location (Typical 8-Cylinder MerCruiser Engine with Breaker Point Ignition)

3. Connect green stop switch harness lead to convenient engine ground.
4. Coat connections with Liquid Neoprene.

MerCruiser Engines with Thunderbolt IV HEI Ignition

1. Tape white stop switch harness lead to harness and insulate with at least two layers of electrical tape.
2. Connect green stop switch harness lead to distributor terminal which has white-green lead already connected on it.
3. Connect black stop switch harness lead to convenient engine ground.
4. Coat connections with Liquid Neoprene.



178-H

a - Emergency Stop Switch
b - Ignition Amplifier
c - Ignition Coil
d - Distributor

Wire Location [MerCruiser Engines with Thunderbolt IV (HEI) Ignition]

Wiring Harness Kit 84-98423A4

For MCM 200MR Installation

⚠WARNING

Disconnect both battery cables from battery to prevent accidental shorting of wires when removing and installing wiring harness.

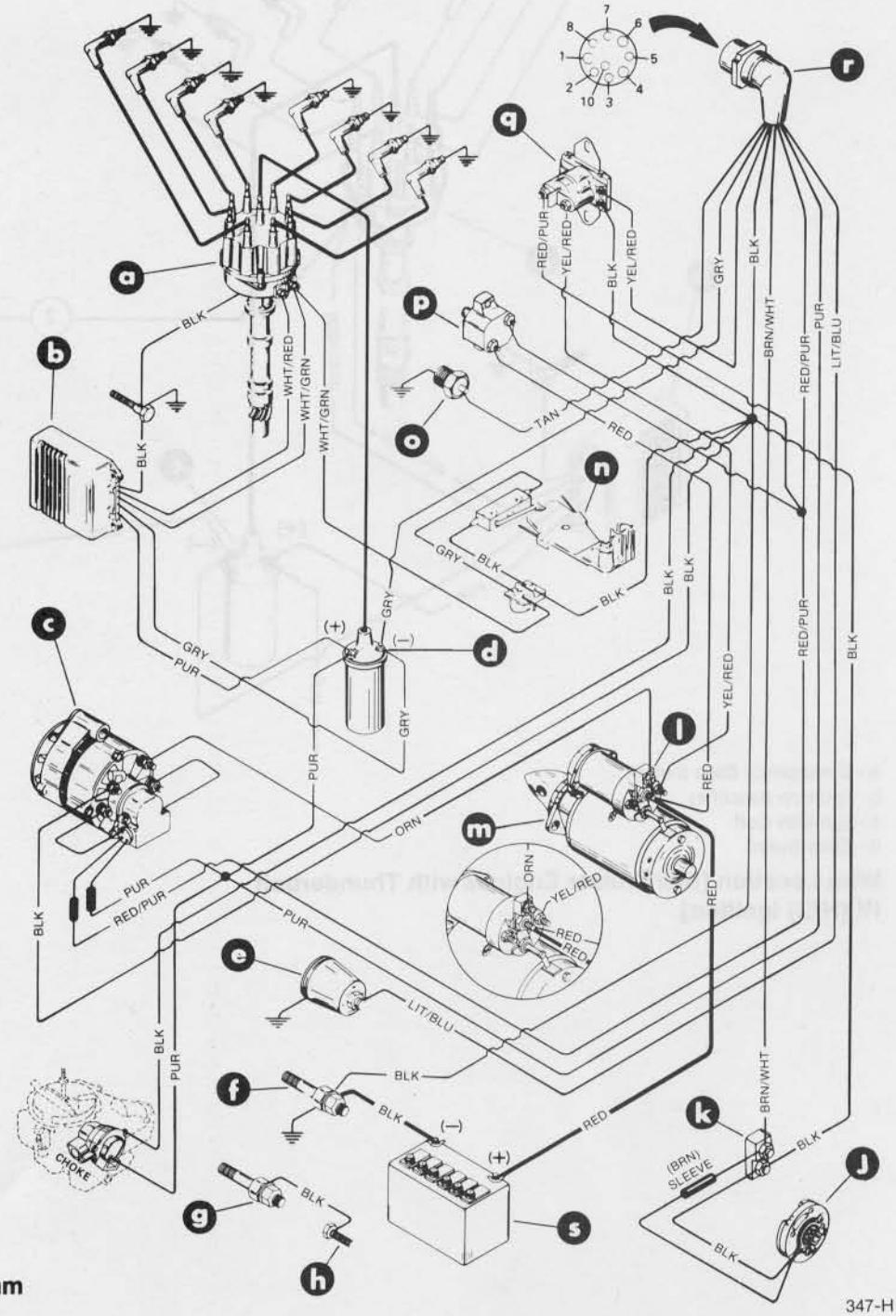
Install wiring harness, as shown, being sure to observe the following:

A Be sure that all "J" clamps, which secure wiring harness, are bent shut.

B Install heat shrink tubing over the quick disconnect terminals at alternator. Be sure that all exposed metal on terminals is covered.

C Position inuslator boots over terminals on wires so equipped.

D Apply a thin coat of Quicksilver Liquid Neoprene (92-25711) to all terminal connections which are not protected by an insulator boot.



a - Distributor
b - Ignition Amplifier
c - Alternator
d - Ignition Coil
e - Oil Pressure Sender
f - Engine Ground Stud
g - Ground Stud on Engine Flywheel Housing
h - Ground Screw on Inner Transom Plate
j - Trim Sender
k - Terminal Block
l - 90 Amp Fuse
m - Starter Motor
n - Shift Cutout Switch
o - Water Temp Sender
p - 60 Amp Circuit Breaker
q - Starter Slave Solenoid
r - Wiring Harness
s - 12-Volt Battery

Engine Electrical System Wiring Diagram

347-H

Wiring Harness Kit 84-86683A2

For MCM 330, 370, 400, 440, 460 Installation

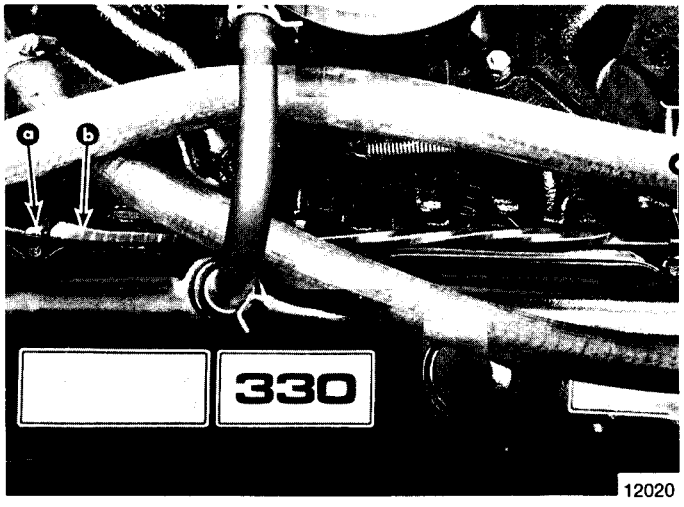
NOTE: The fasteners, which are provided with this wiring harness must be used, as explained in the following instructions, when the harness is installed on MCM 330 Engines below Serial No. 5354658. Engines with Serial No. 5354658 and above already have the fasteners installed.

⚠WARNING

Disconnect both battery cables from battery to prevent accidental shorting of wires when removing and installing wiring harness.

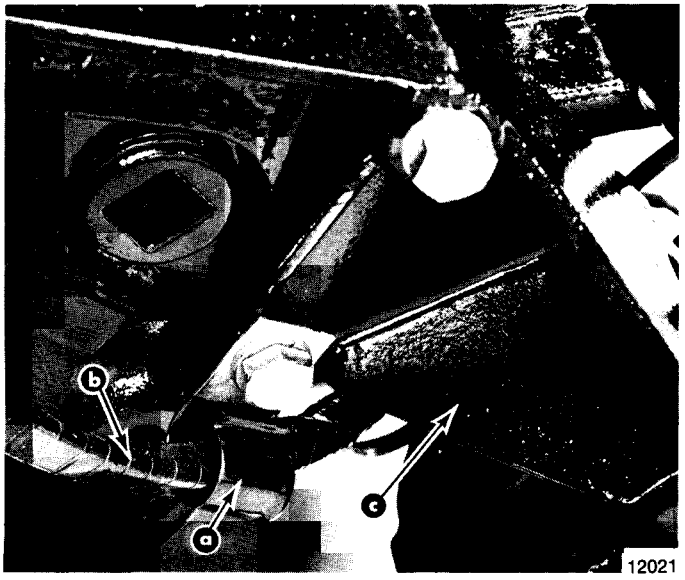
This wiring harness has BIA standard color codes. Harness must be installed and secured with fasteners provided, as explained, following.

1. Remove (and discard) old wiring harness. Retain harness mounting plate and 4 attaching screws and all terminal fsteners.
2. Install wiring harness receptacle in wiring harness bracket and secure with mounting plate and 4 screws (retained in Step 1).
3. Route wiring harness and install fasteners provided with harness, as follows:
   a. Remove screws from rocker arm cover (on port side of engine) and install J-clamps with 9/32" (7mm) attaching hole, as shown. Torque screws to 48 lbs. in. (5.4 N.m). Route long section of harness thru clamps and bend clamps shut.



a - J-Clamps (9/32" Attaching Hole)
b - Wiring Harness

   b. Remove bottom attaching screw from alternator bracket and install J-clamp with 13/32" (10mm) attaching hole, as shown. Torque screw to 25 lbs. ft. (34 N.m). Route end of harness thru clamp to alternator and bend clamp shut.



a - J-Clamp (13/32" Attaching Hole)
b - Wiring Harness
c - Alternator Bracket

   c. Route short section of wiring harness (wires "a", "b" and "c") over to starter.
4. If engine is equipped with a fuse on starter solenoid, remove (and discard) fuse.
5. Connect wiring harness leads to electrical components as shown, being sure to complete the following:
   a. Position insulator boots over terminals on wires so equipped.
   b. Apply a coat of Liquid Neoprene to all terminal connections which are not protected by an insulator boot.
   c. Place heat shrink tubing (supplied with kit) over end of leads coming from alternator. Connect purple engine harness lead to purple (or white) alternator lead. Connect red-purple engine harness lead to red-purple (or red) alternator lead. Position heat shrink tubing over connections and heat with heat gun until secure.
   d. MCM engines, that are equipped with Delco single-wire alternators, do not use the purple and red-purple alternator leads (items "s" and "t"). On these engines, the purple and red-purple leads must be insulated and taped back to wiring harness, as follows:

⚠CAUTION

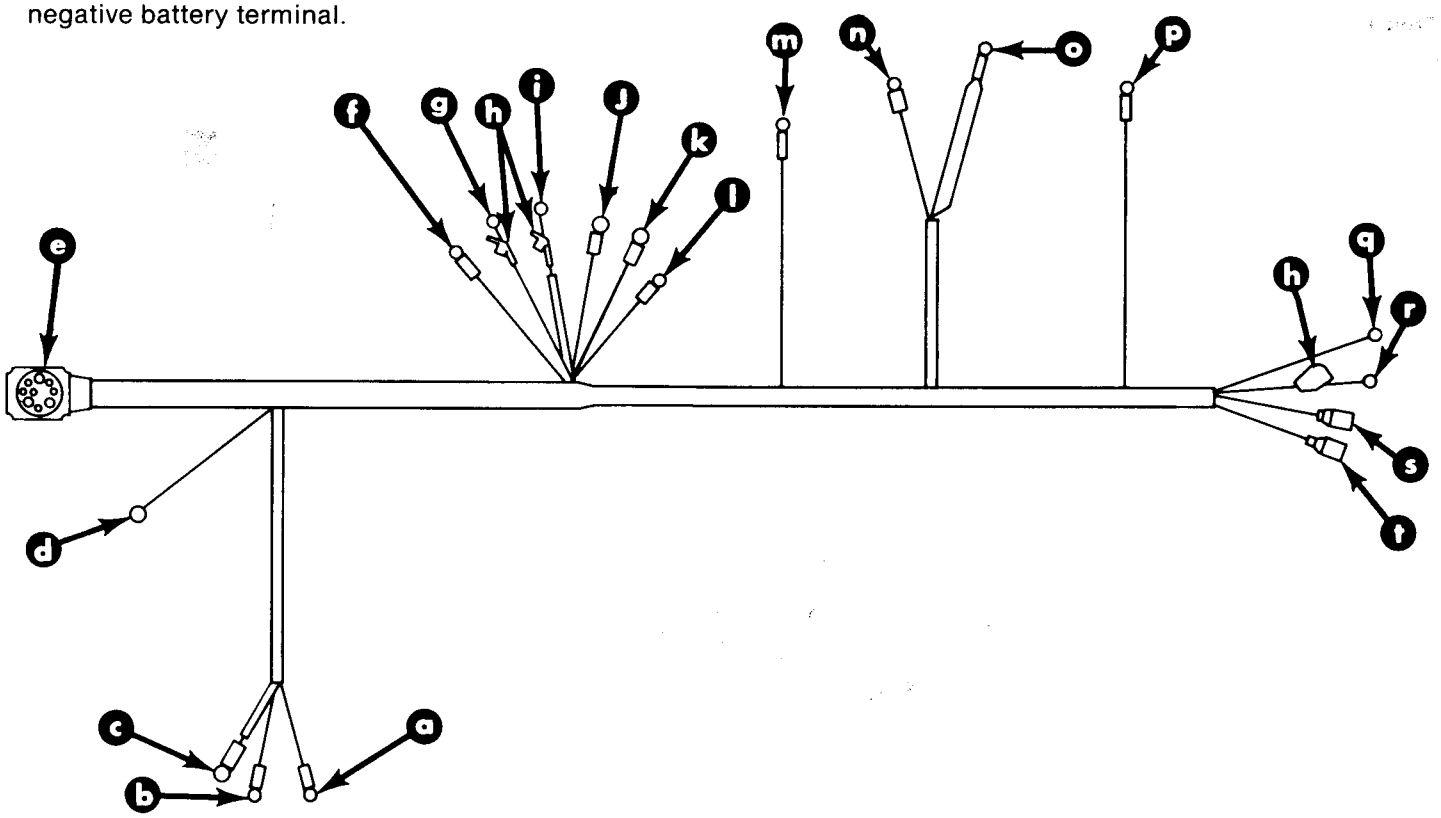
Failure to adequately insulate the purple and red-purple leads, as explained in 1), 2), 3) following, can result in electrical failure.

1) Fold terminal on end of purple lead back against purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminal.

2) Fold terminal on end of red-purple lead back against red-purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminals.

3) Fold insulated purple and red-purple leads back against harness and secure with electrical tape.

6. After making all necessary harness connections, reconnect positive (+) battery cable to positive battery terminal and negative (-) battery cable to negative battery terminal.

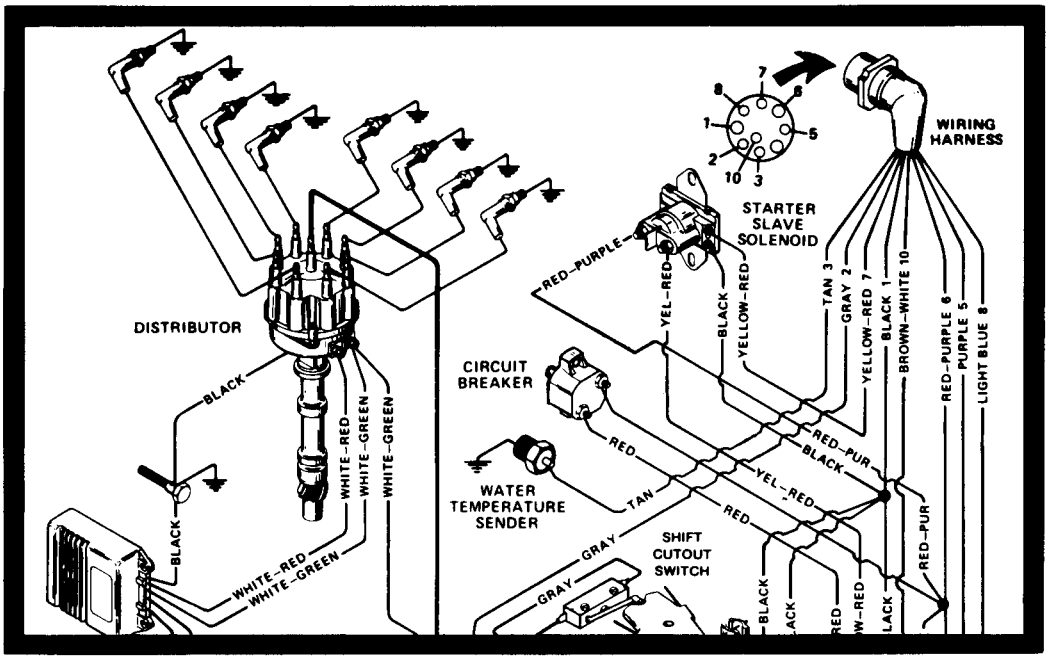


a - Yellow-Red Wire - Connect to "S" Terminal on Starter Mounted Solenoid
b - Purple-Yellow Wire - Connect to "R" Terminal on Starter Mounted Solenoid
c - Red Wire - Connect to Large Terminal on Starter Mounted Solenoid
d - Black Wire - Connect to Flywheel Housing Attaching Screw on Starboard Side of Engine
e - Receptacle
f - Brown-White Wires - Connect to Insulated Terminal on Trim Position Sender Terminal Block
g - Red-Purple Wire - Connect to Upper Terminal on Circuit Breaker
h - Insulator Boot
i - Red Wire - Connect to Lower Terminal on Circuit Breaker
j - Red-Purple Wire - Connect to One Large Terminal on Slave Solenoid
k - Yellow-Red Wire - Connect to Other Large Terminal on Slave Solenoid
l - Yellow-Red Wire - Connect to Small Lower Terminal on Slave Solenoid
m - Light Blue Wire - Connect to Oil Pressure Sender on Port Side of Engine
n - Gray Wire - Connect to Negative (-) Terminal on Ignition Coil
o - Purple-Yellow and Purple Wires - Connect to Positive (+) Terminal on Ignition Coil
p - Tan Wire - Connect to Water Temperature Sender on Starboard Side of Intake Manifold Near Thermostat Housing
q - Black Wire - Connect to Alternotor Ground Terminal
r - Orange Wire - Connect to Alternator Output ("BAT") Terminal
*s - Purple Wire - Connect to Alternator Purple (or White) Wire
*t - Red-Purple Wire - Connect to Alternator Red-Purple (or Red) Wires

*Install and shrink sleeves (supplied with harness) over these quick disconnect termimals. Be sure that all exposed metal on the terminals is covered.

Wiring Harness (84-86683A2) Electrical Connections

ELECTRICAL SYSTEM



WIRING DIAGRAMS

4

F

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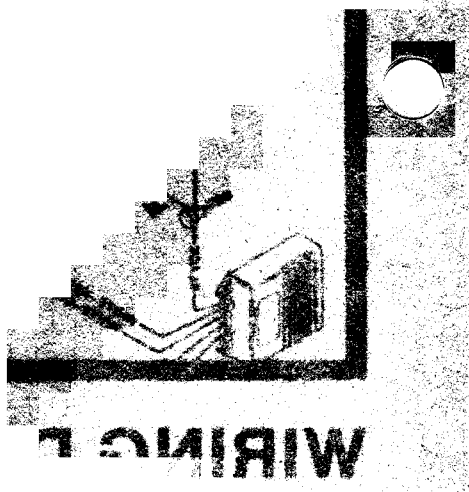
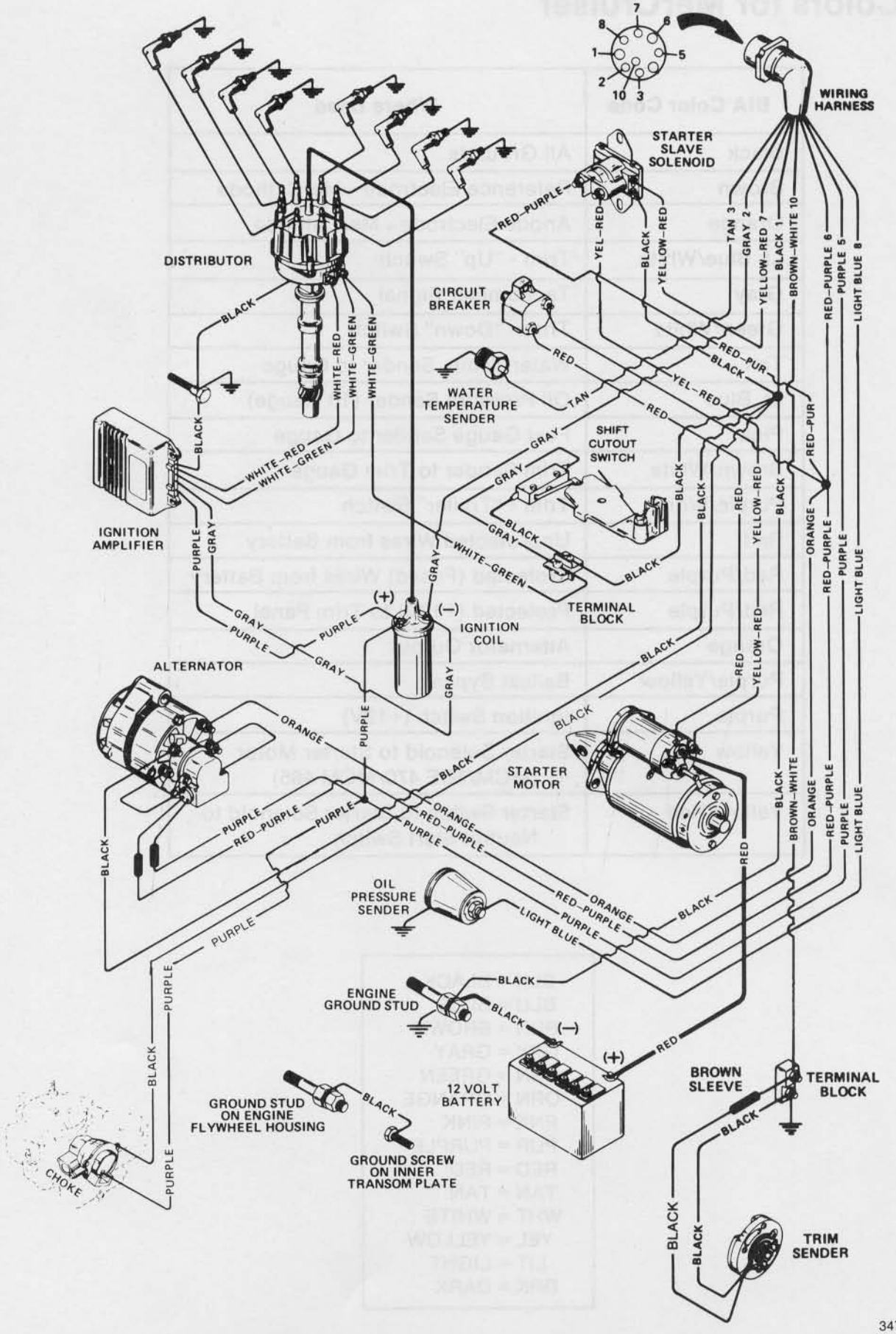


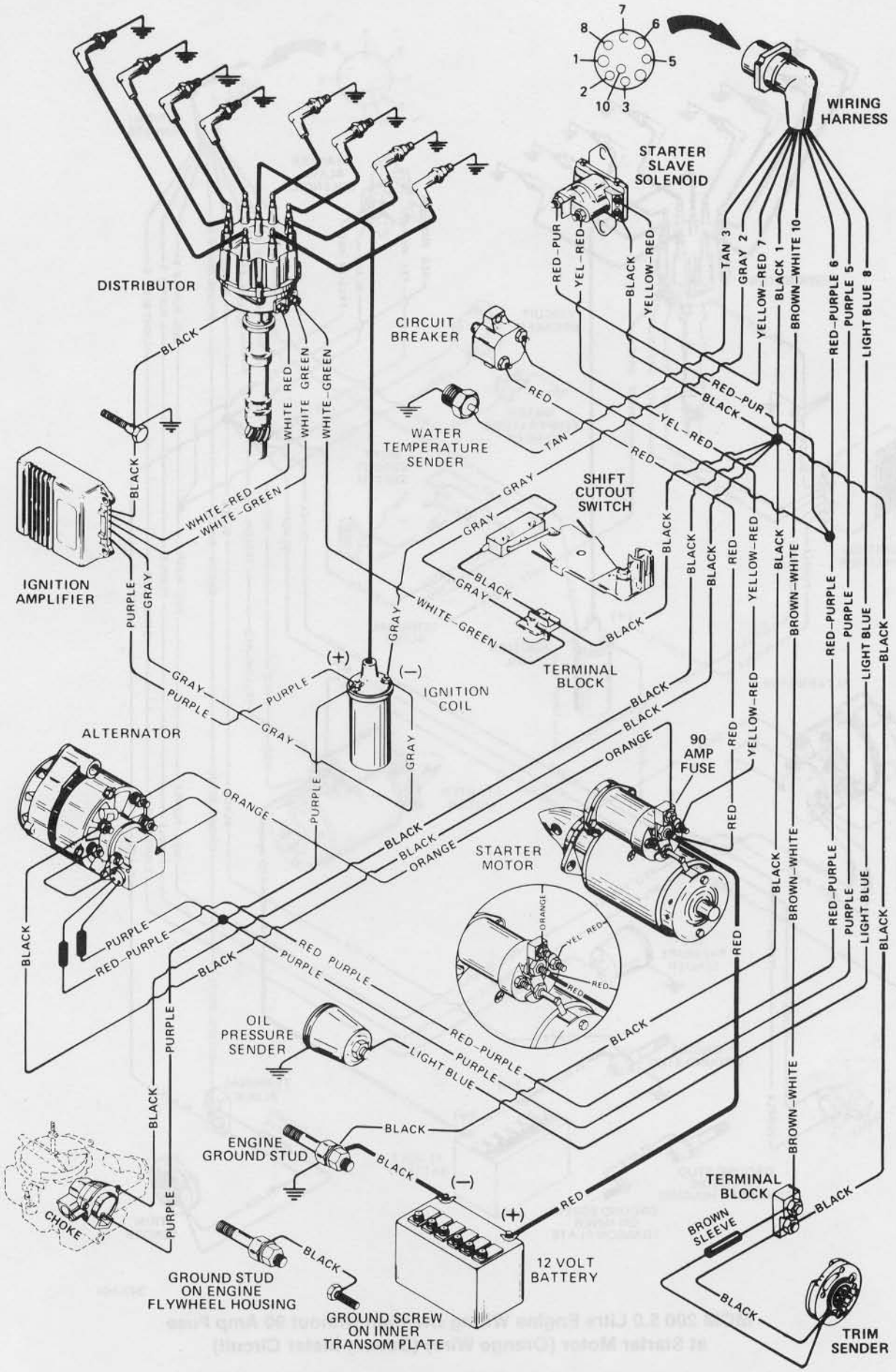
Wiring Colors for MerCruiser

BIA Color Code	Where Used
Black	All Grounds
Brown	Reference Electrode - MerCathode
Orange	Anode Electrode - MerCathode
Lt. Blue/White	Trim - "Up" Switch
Gray	Tachometer Signal
Green/White	Trim - "Down" Switch
Tan	Water Temp. Sender to Gauge
Lt. Blue	Oil Pressure Sender (10 Gauge)
Pink	Fuel Gauge Sender to Gauge
Brown/White	Trim Sender to Trim Gauge
Purple/White	Trim - "Trailer" Switch
Red	Unprotected Wires from Battery
Red/Purple	Protected (Fused) Wires from Battery
Red/Purple	Protected (+12V) to Trim Panel
Orange	Alternator Output
Purple/Yellow	Ballast Bypass
Purple	Ignition Switch (+12V)
Yellow	Starter Solenoid to Starter Motor (MCM/MIE 470/MCM 485)
Yellow/Red	Starter Switch to Starter Solenoid to Neutral Start Switch

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK

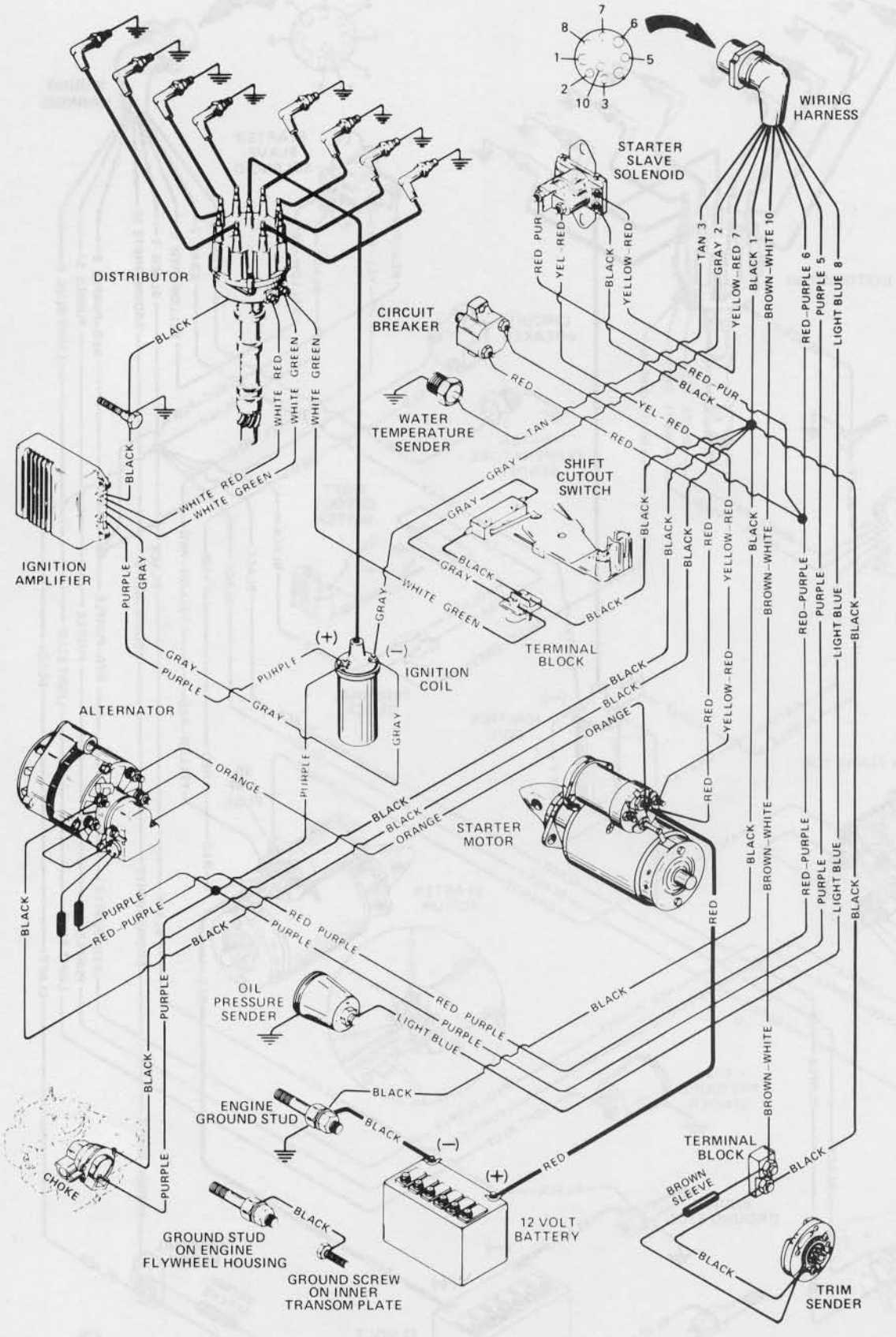


MCM 200 5.0 Litre Engine (Battery Meter Circuit)

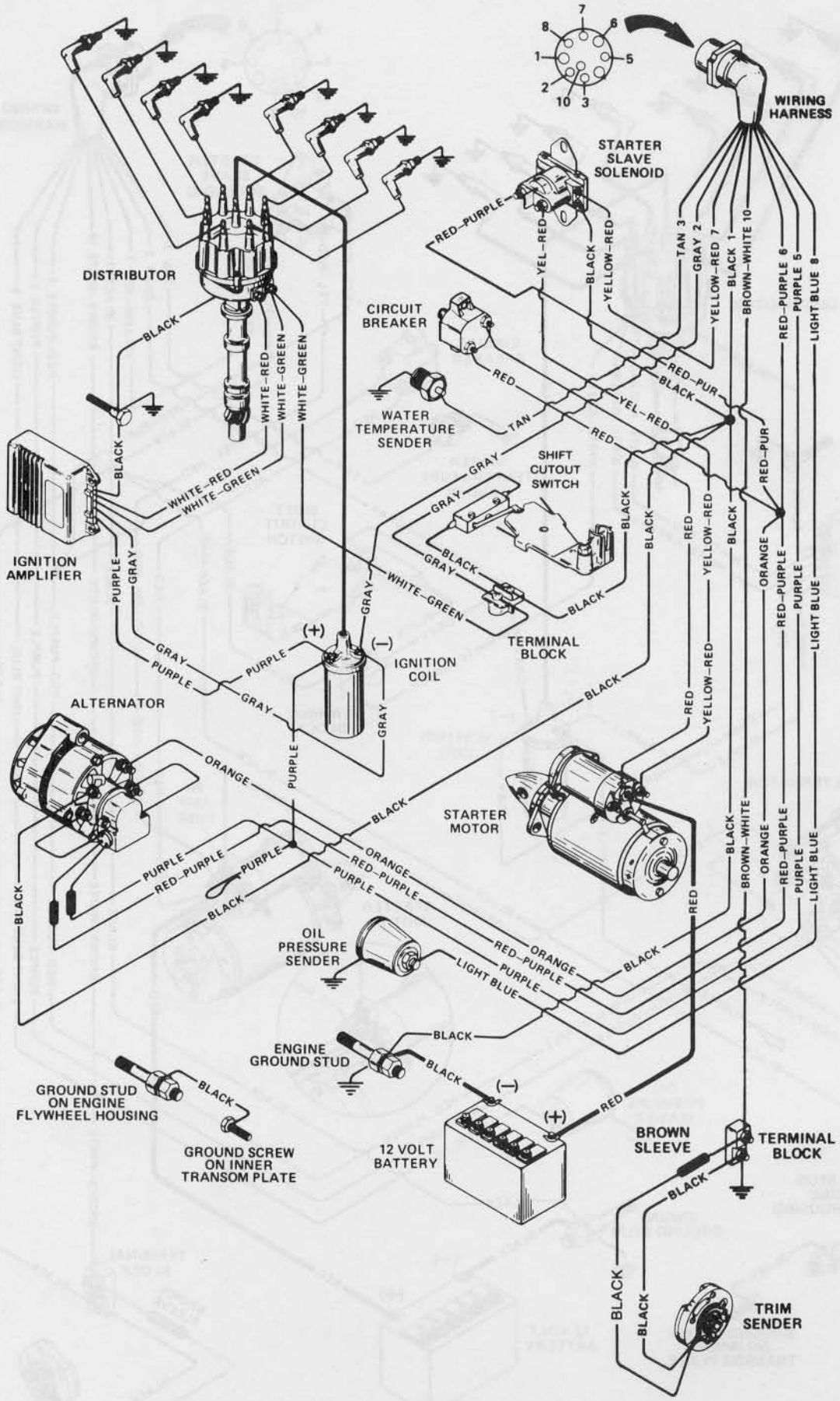


MCM 200 5.0 Litre Engine with 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)

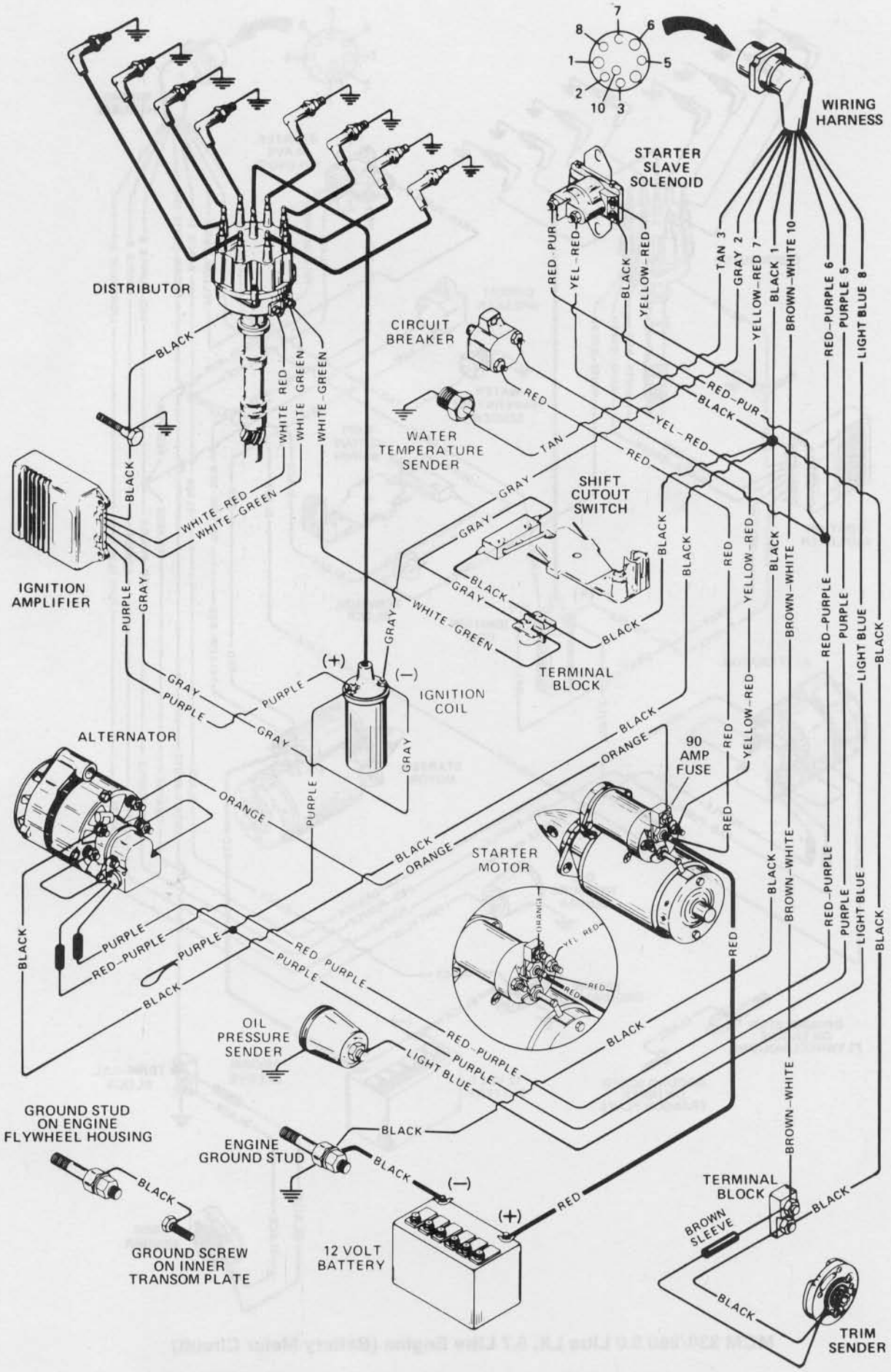
347-H



MCM 200 5.0 Litre Engine Wiring Diagram without 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)

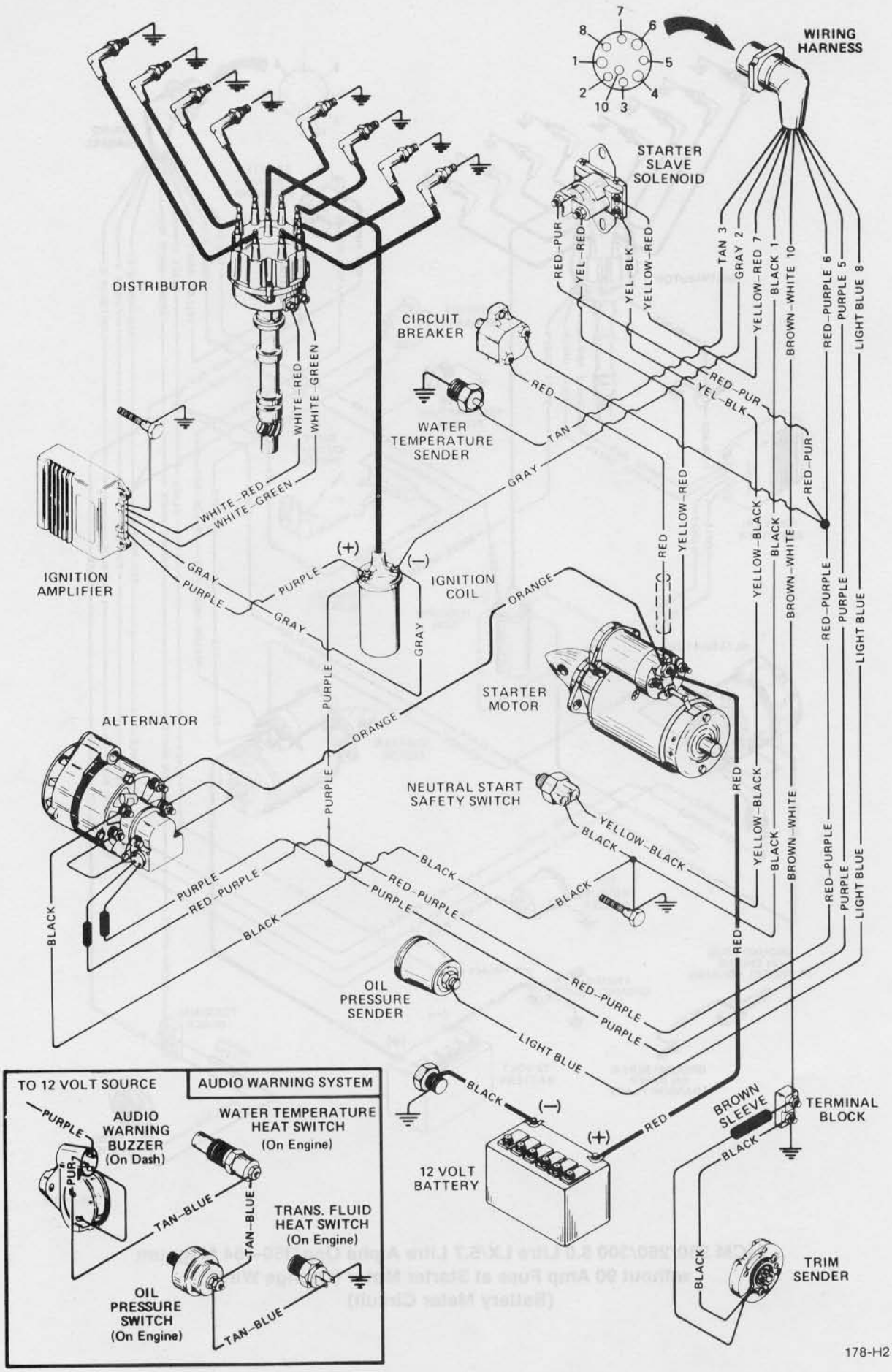


MCM 230/260 5.0 Litre LX, 5.7 Litre Engine (Battery Meter Circuit)

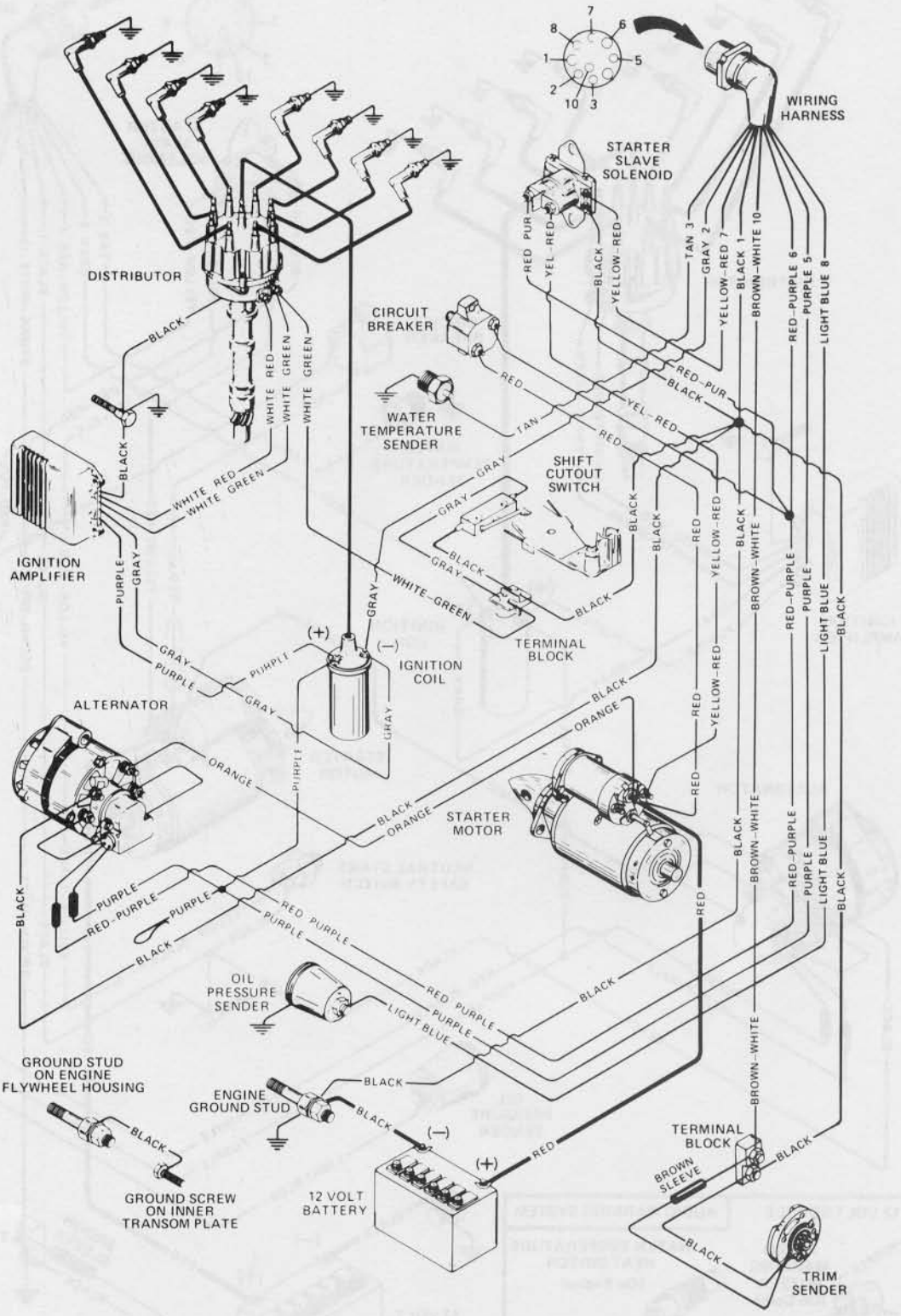


MCM 230/260 5.0 Litre LX/5.7 Litre Engine with 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)

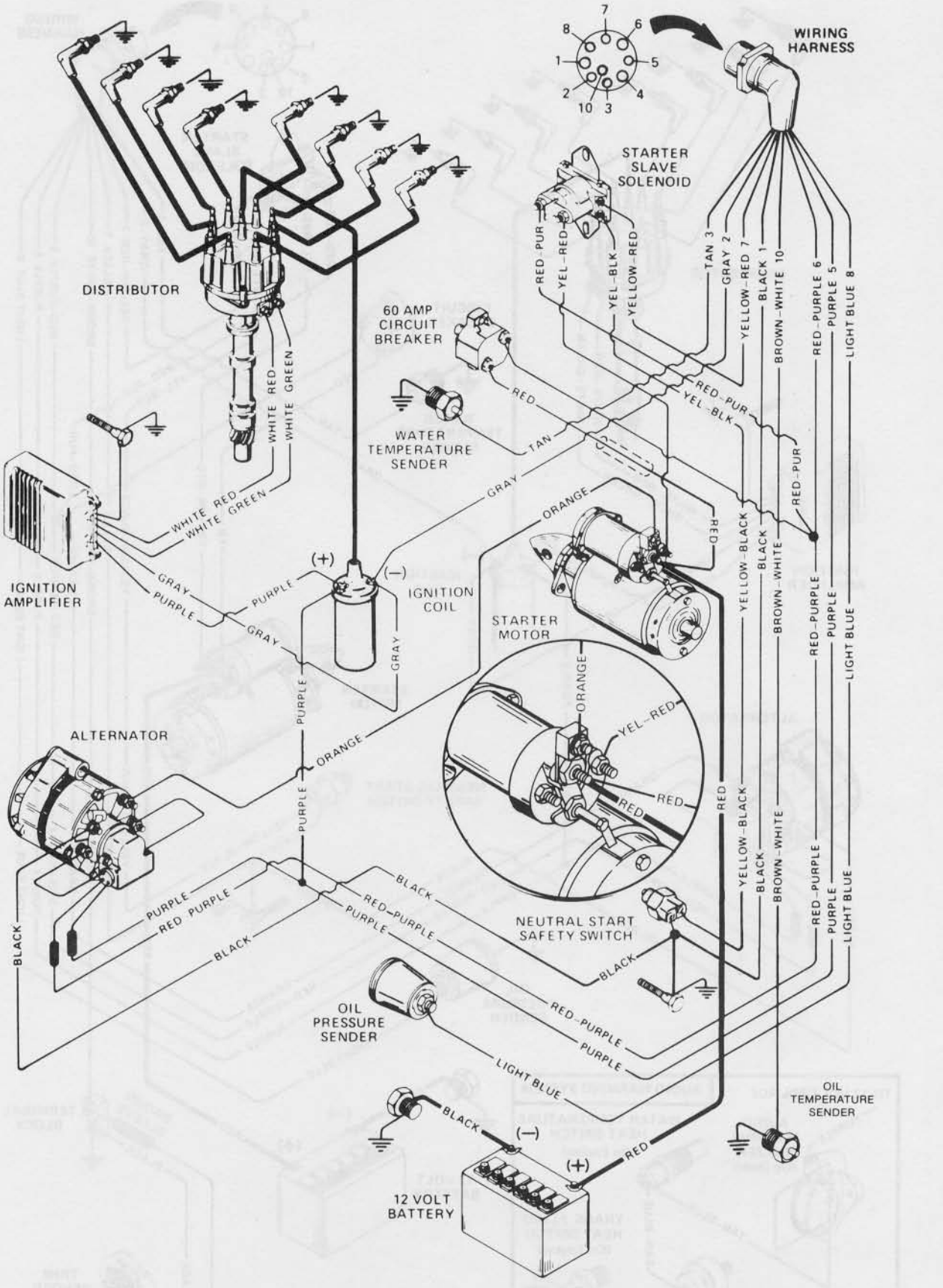
335-HR



MCM 230TR/260TR 5.7 Litre TR Engine (Battery Meter Circuit)

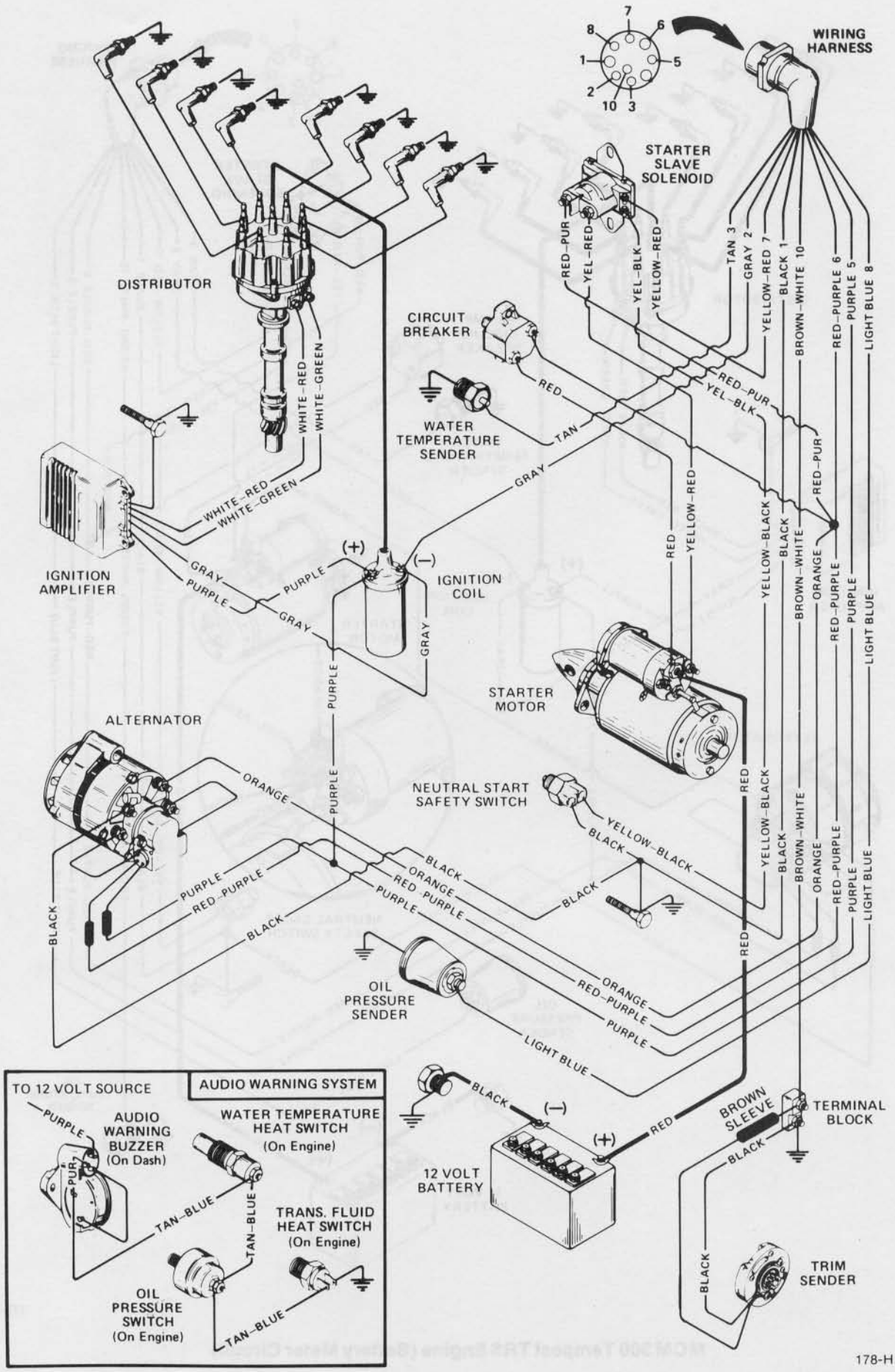


MCM 230/260/300 5.0 Litre LX/5.7 Litre Alpha One/350-454 Magnum without 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)

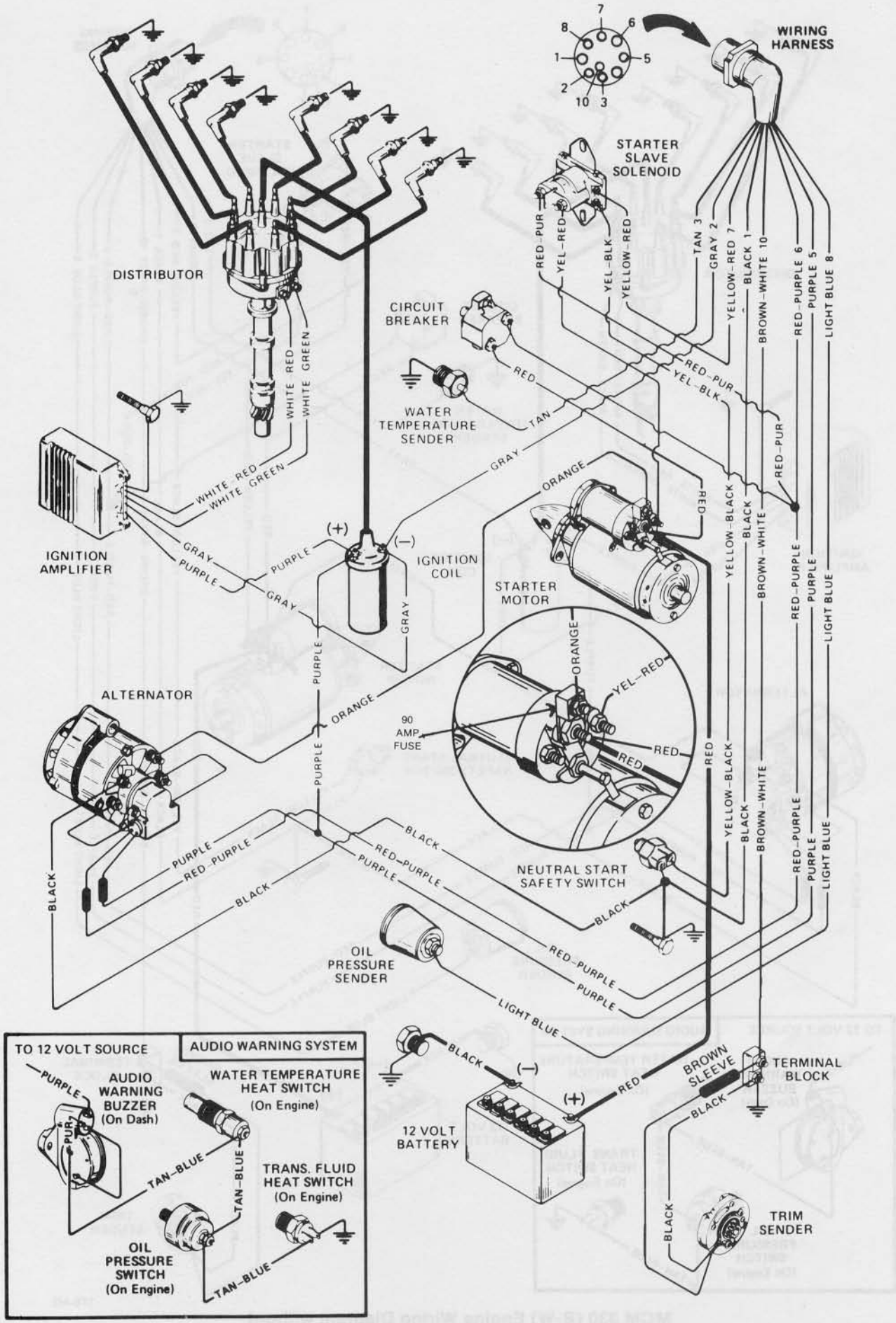


178-HR-A

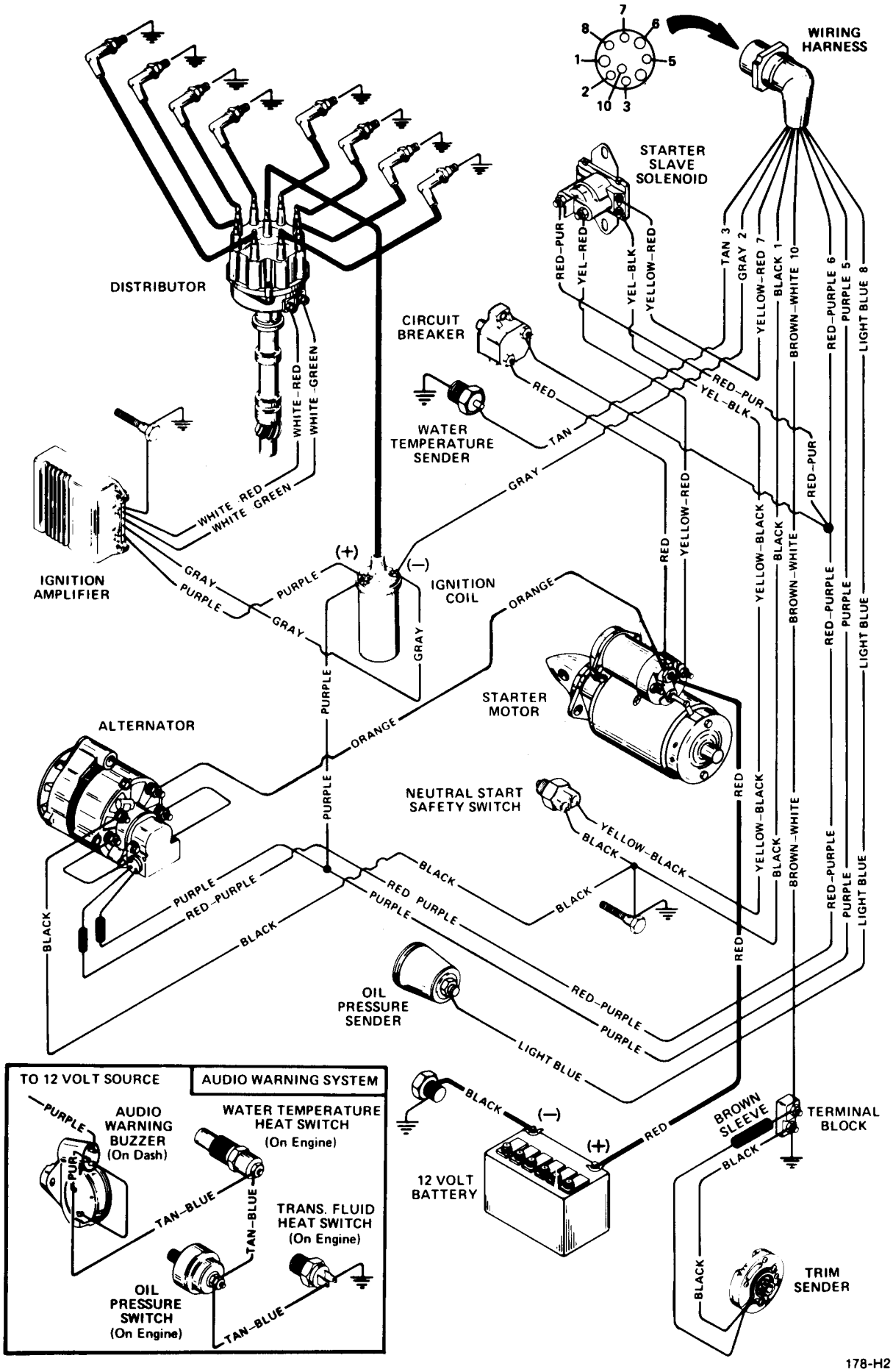
MCM 300 Tempest TRS Engine (Battery Meter Circuit)



MCM 330 (B-W) Engine (Battery Meter Circuit)

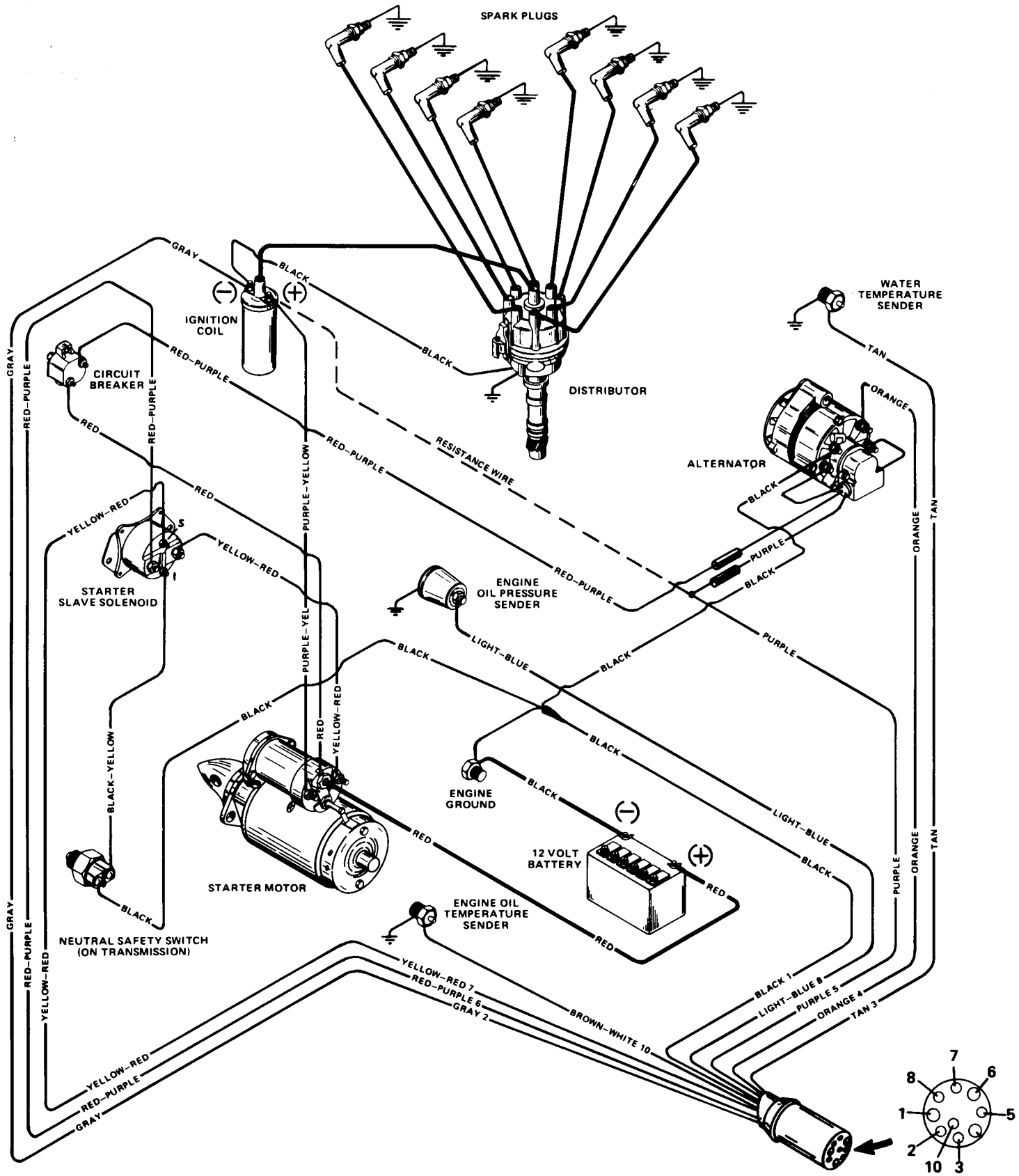


MCM 330 (B-W) Engine with 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)



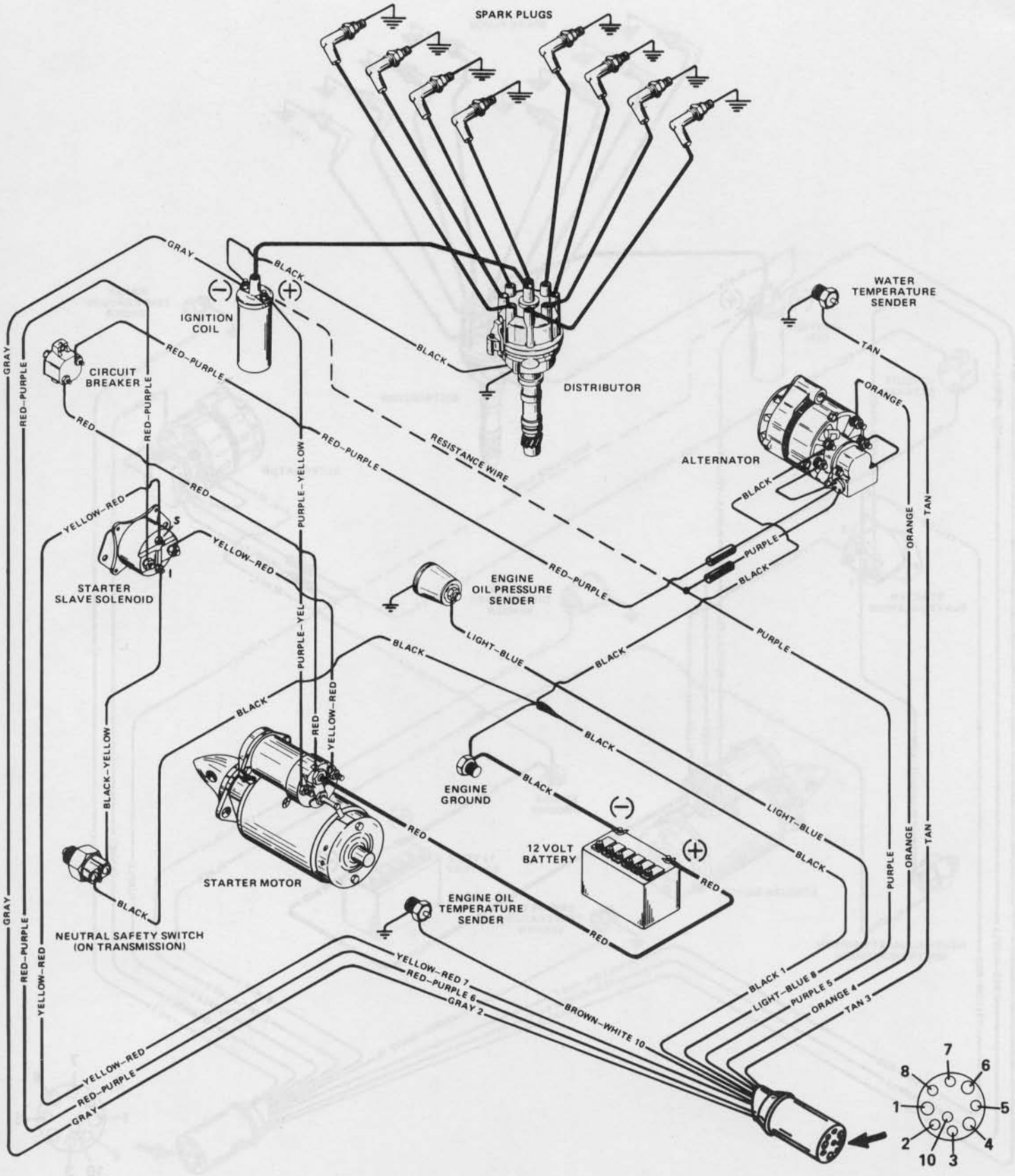
178-H2

MCM 330 (B-W) Engine Wiring Diagram without 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)



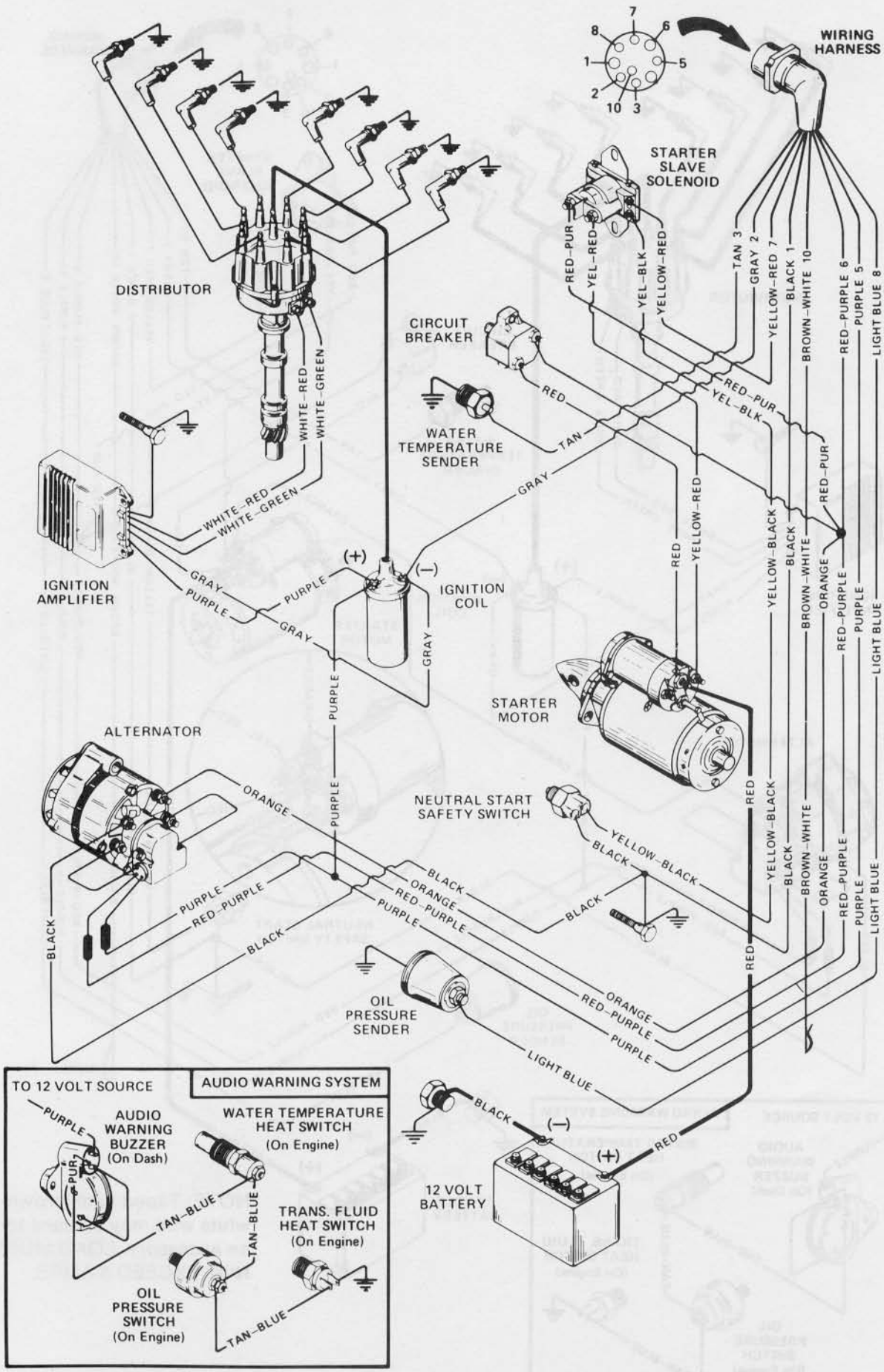
MCM 370/400TRS Engine (Ammeter Circuit)

512-11

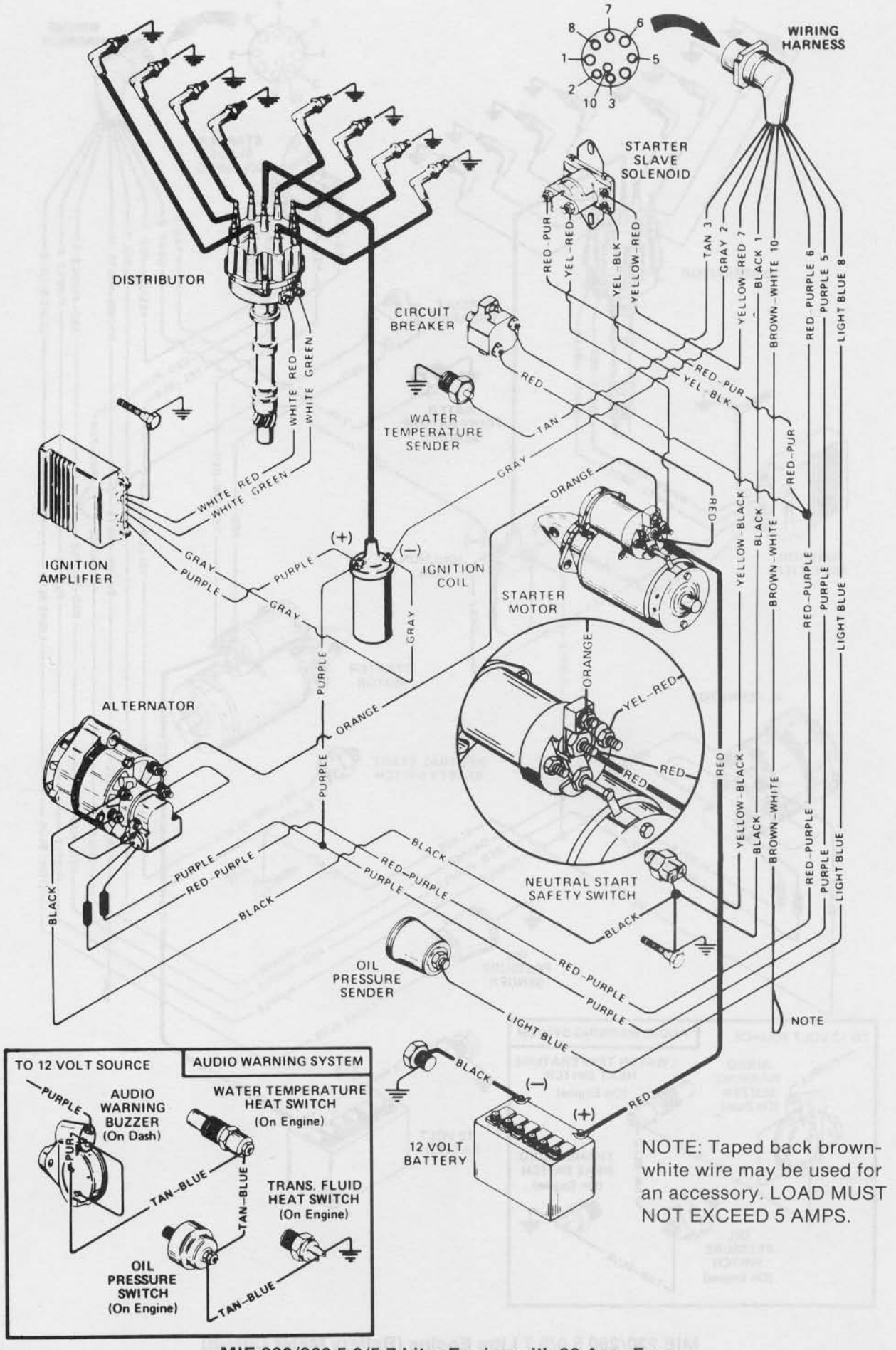


512-11

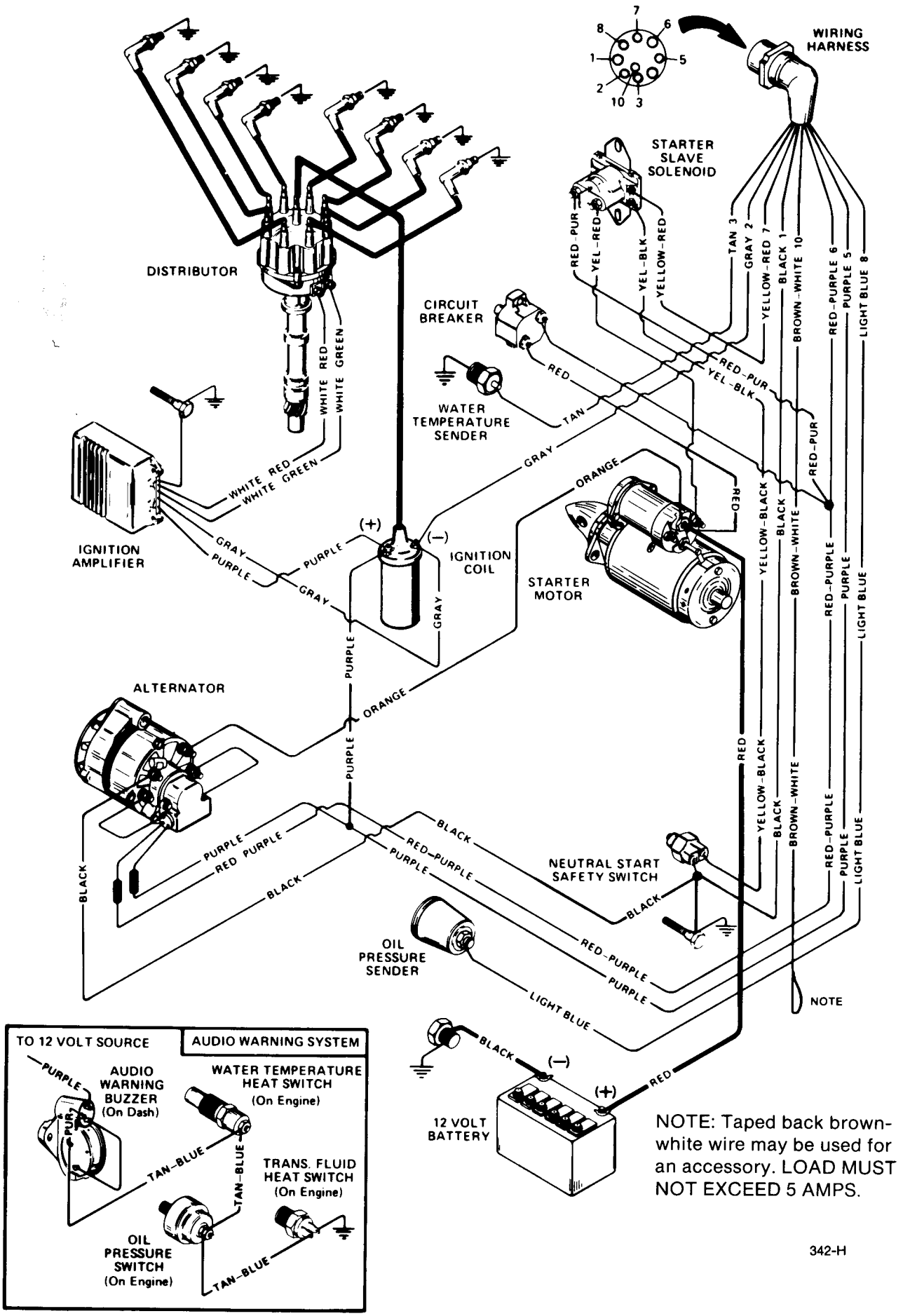
MCM 400 Cyclone, 440 Cyclone, 460 Cyclone Engine (Ammeter Circuit)



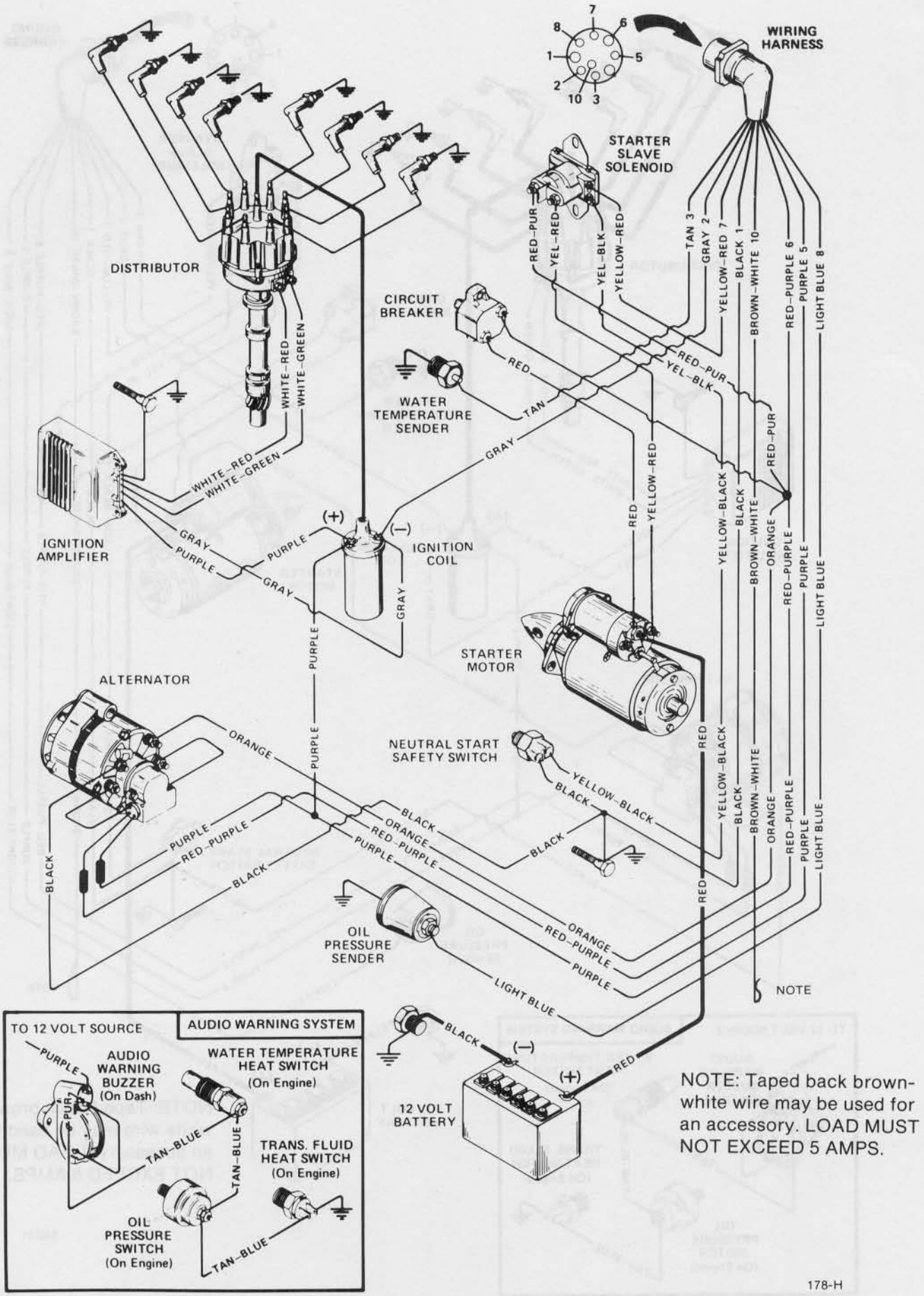
MIE 230/260 5.0/5.7 Litre Engine (Battery Meter Circuit)



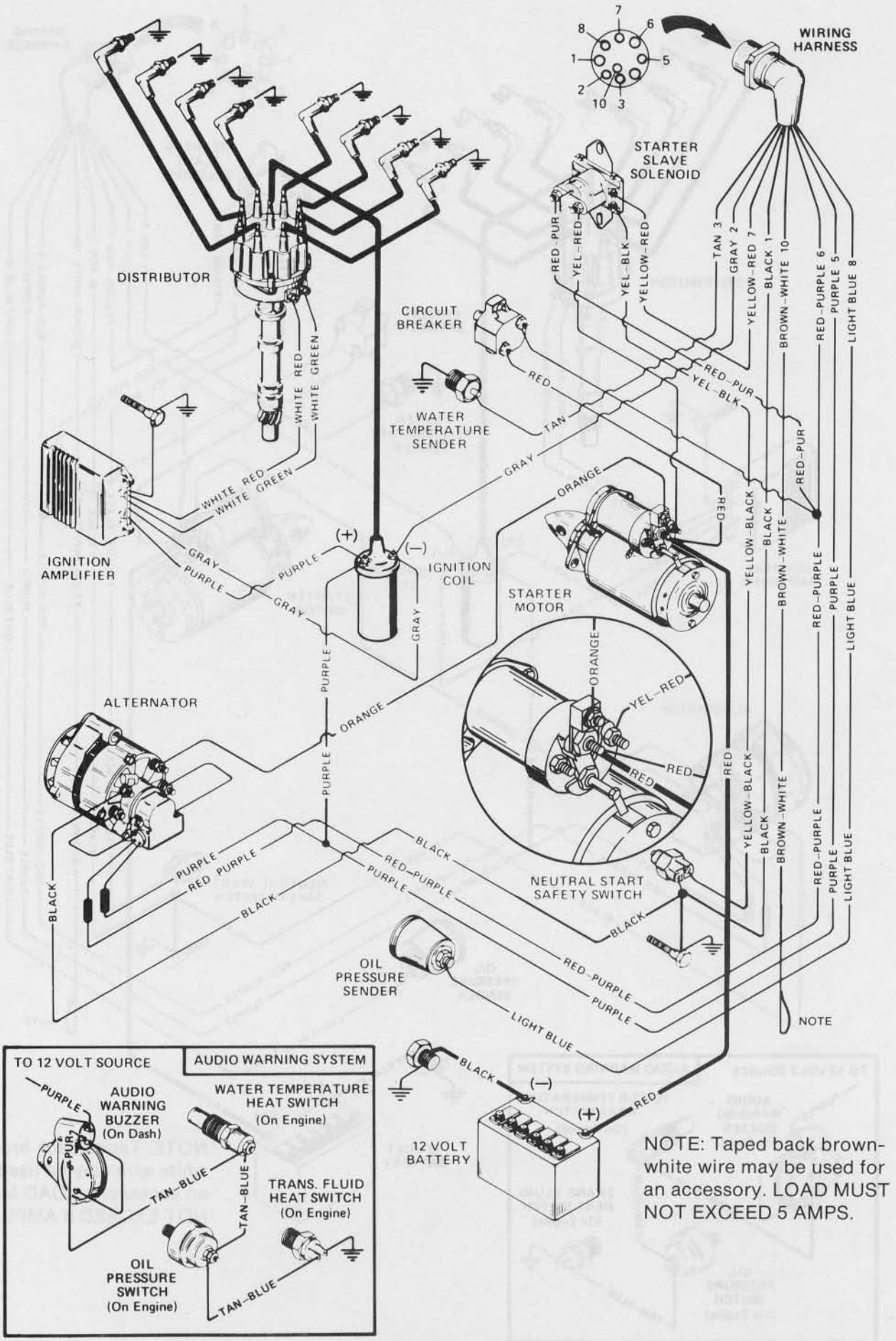
MIE 230/260 5.0/5.7 Litre Engine with 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)



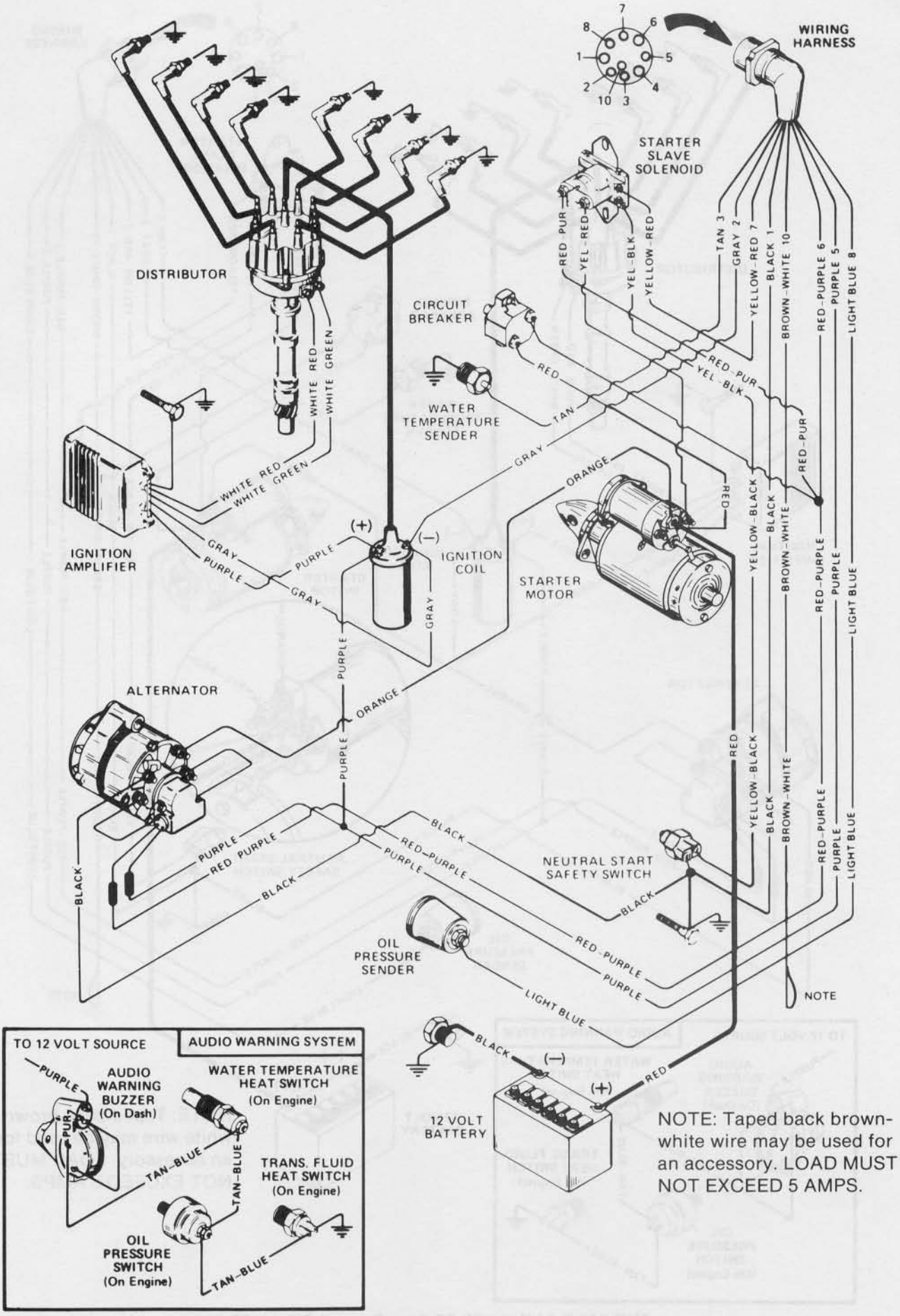
MIE 230/260 5.0/5.7 Litre Engine without 90 Amp Fuse at Motor (Orange Wire) (Battery Meter Circuit)



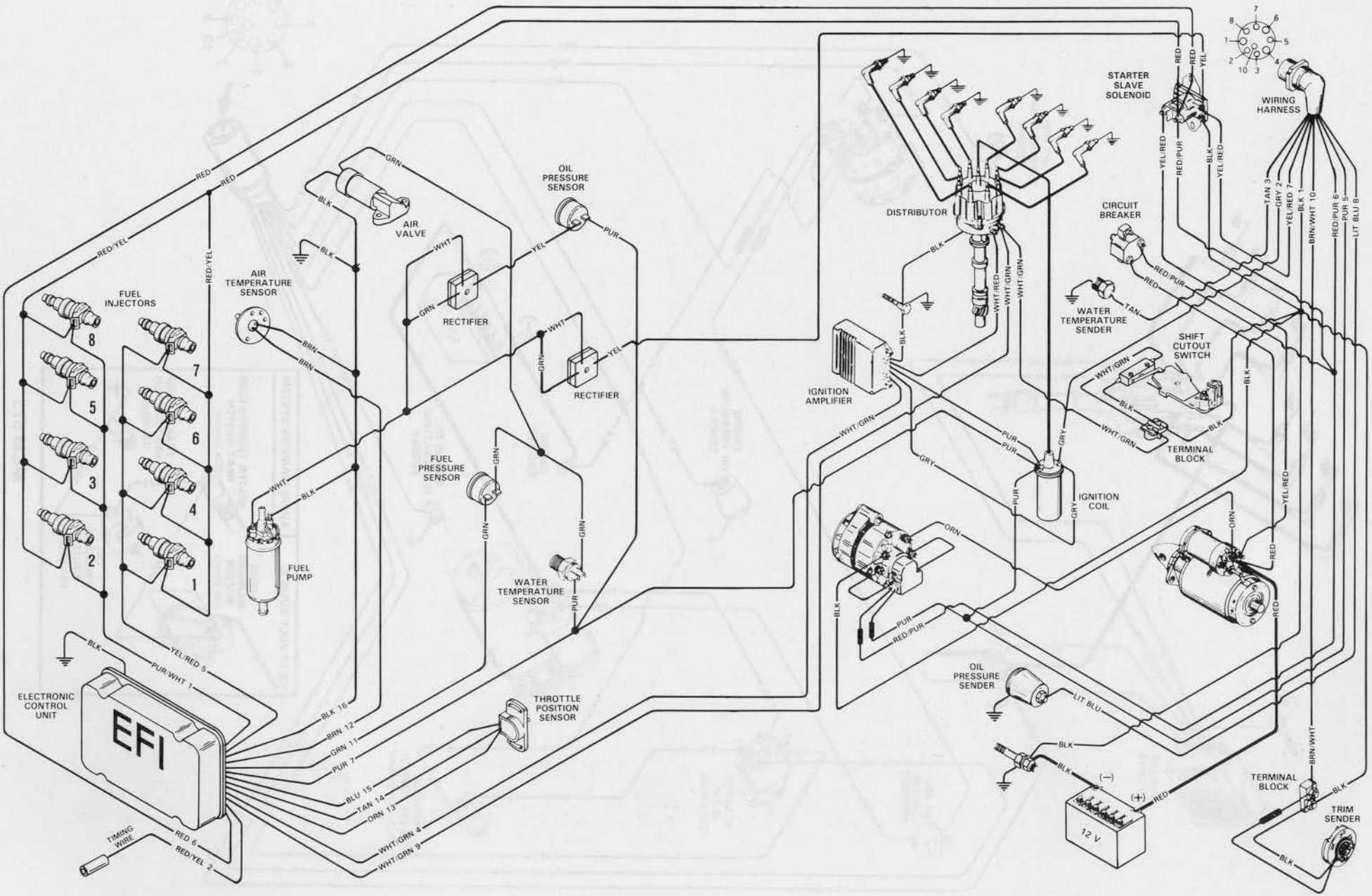
MIE 340 7.4 Litre Engine (Battery Meter Circuit)



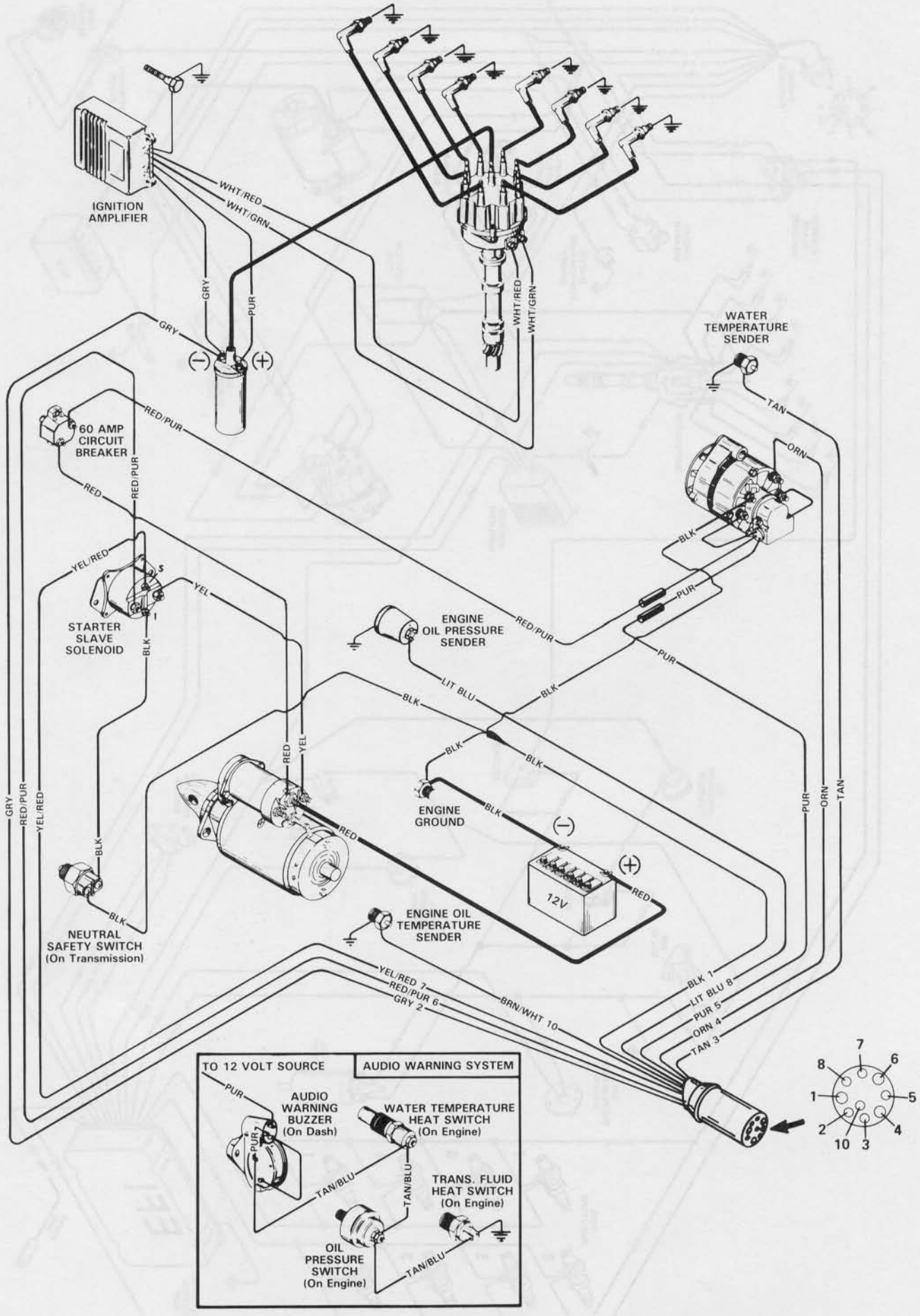
MIE 340 7.4 Liter with 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)



MIE 340 7.4 Litre Engine with 90 Amp Fuse at Starter Motor (Orange Wire) (Battery Meter Circuit)

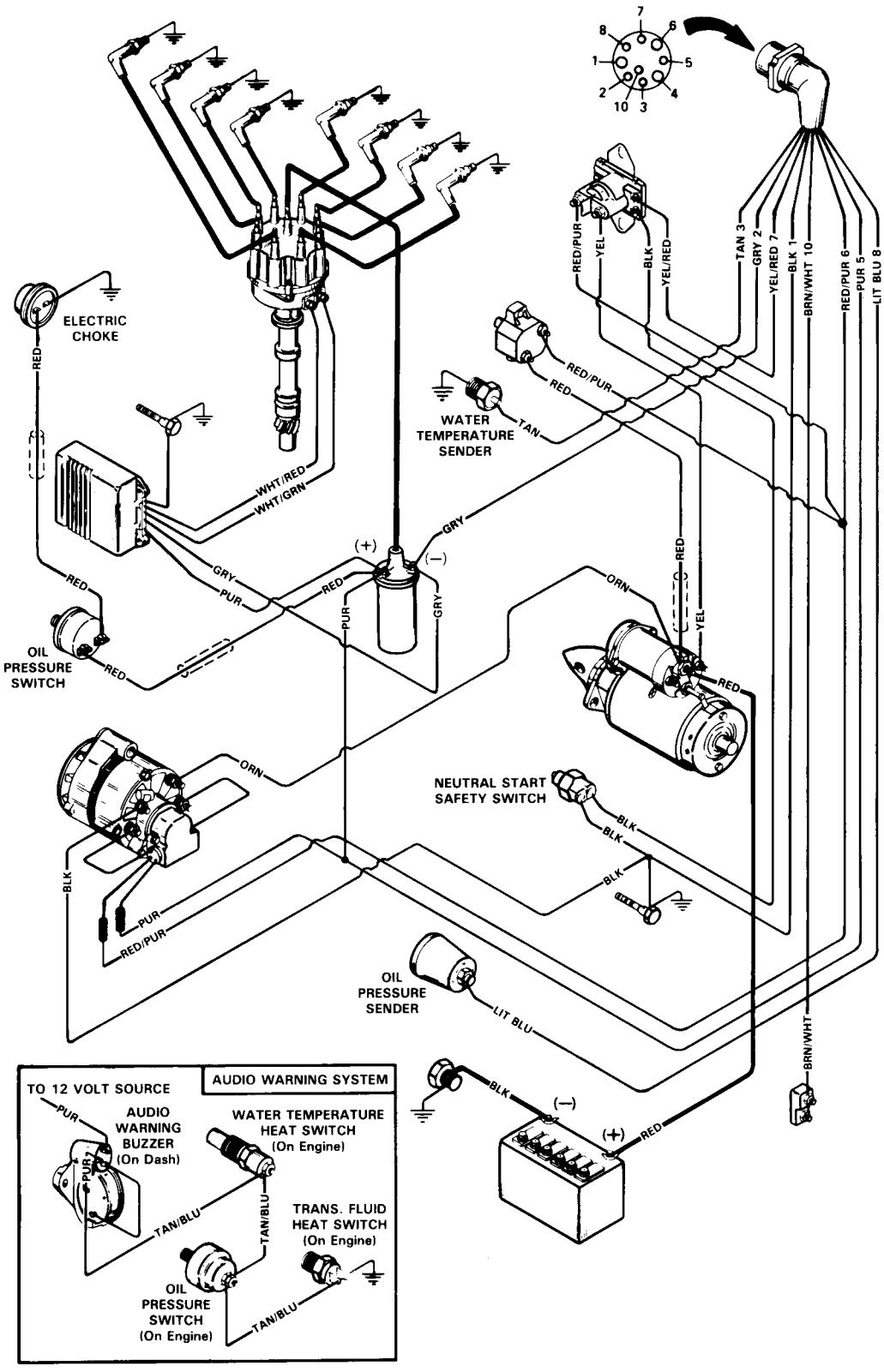

FUEL INJECTORS
AIR TEMPERATURE SENSOR
AIR VALVE
RECTIFIER
OIL PRESSURE SENSOR
RECTIFIER
FUEL PRESSURE SENSOR
FUEL PUMP
WATER TEMPERATURE SENSOR
THROTTLE POSITION SENSOR
ELECTRONIC CONTROL UNIT
EFI
TIMING WIRE
DISTRIBUTOR
IGNITION AMPLIFIER
IGNITION COIL
STARTER SLAVE SOLENOID
CIRCUIT BREAKER
WATER TEMPERATURE SENDER
SHIFT CUTOUT SWITCH
TERMINAL BLOCK
WIRING HARNESS
OIL PRESSURE SENDER
TERMINAL BLOCK
TRIM SENDER
12 V.
(−)
(+)

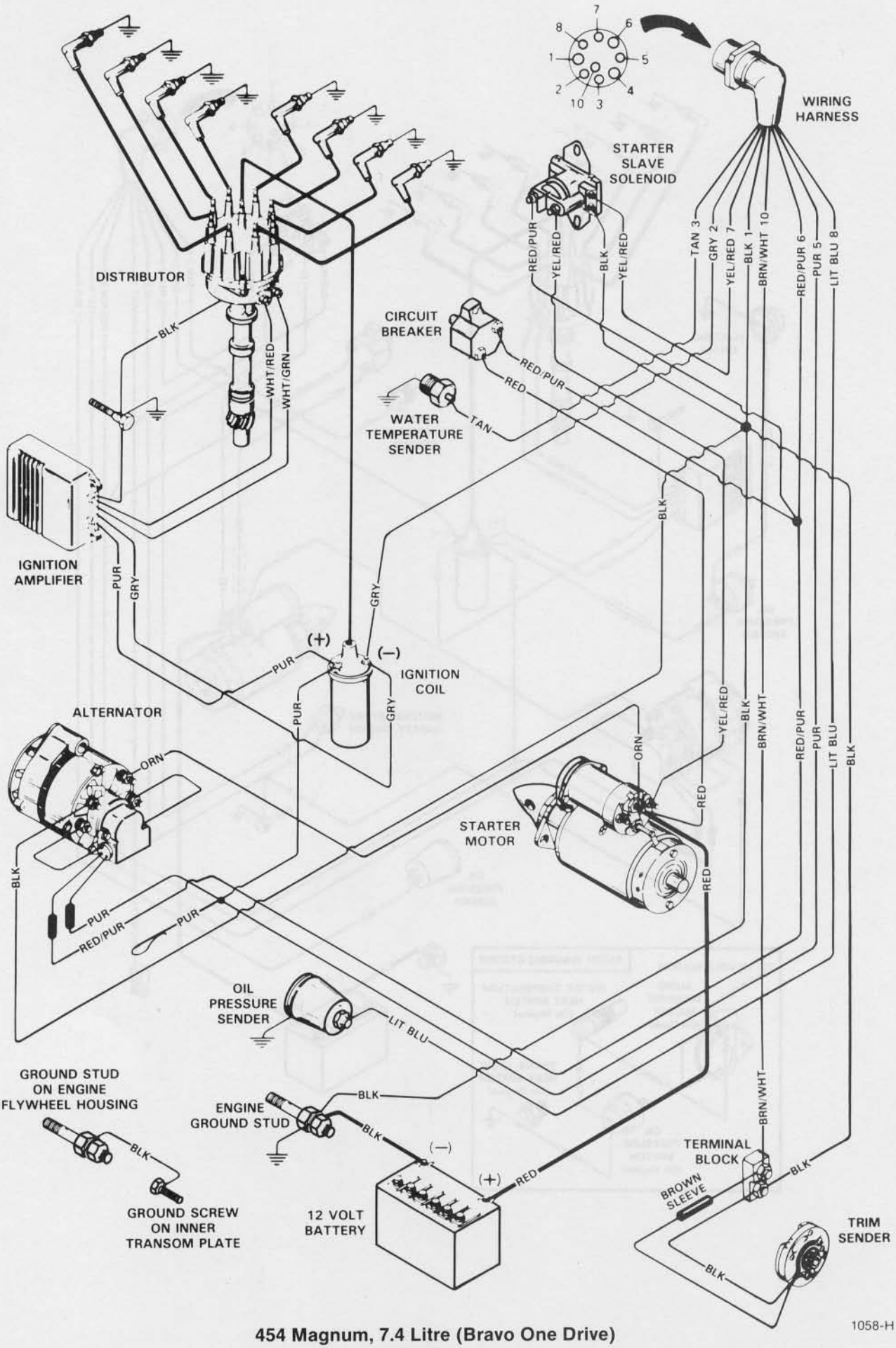
EFI


IGNITION AMPLIFIER
WHT/RED
WHT/GRN
GRY
PUR
WHT/RED
WHT/GRN
WATER TEMPERATURE SENDER
TAN
ORN
60 AMP CIRCUIT BREAKER
RED/PUR
RED
YEL/RED
YEL
BLK
STARTER SLAVE SOLENOID
ENGINE OIL PRESSURE SENDER
PUR
LIT BLU
BLK
RED
ENGINE GROUND
12V
ENGINE OIL TEMPERATURE SENDER
NEUTRAL SAFETY SWITCH (On Transmission)
GRY
YEL/RED 7
RED/PUR 6
GRY 2
BRN/WHT 10
BLK 1
LIT BLU 8
PUR 5
ORN 4
TAN 3
TO 12 VOLT SOURCE
AUDIO WARNING SYSTEM
AUDIO WARNING BUZZER (On Dash)
WATER TEMPERATURE HEAT SWITCH (On Engine)
TRANS. FLUID HEAT SWITCH (On Engine)
OIL PRESSURE SWITCH (On Engine)
TAN/BLU

MCM 575

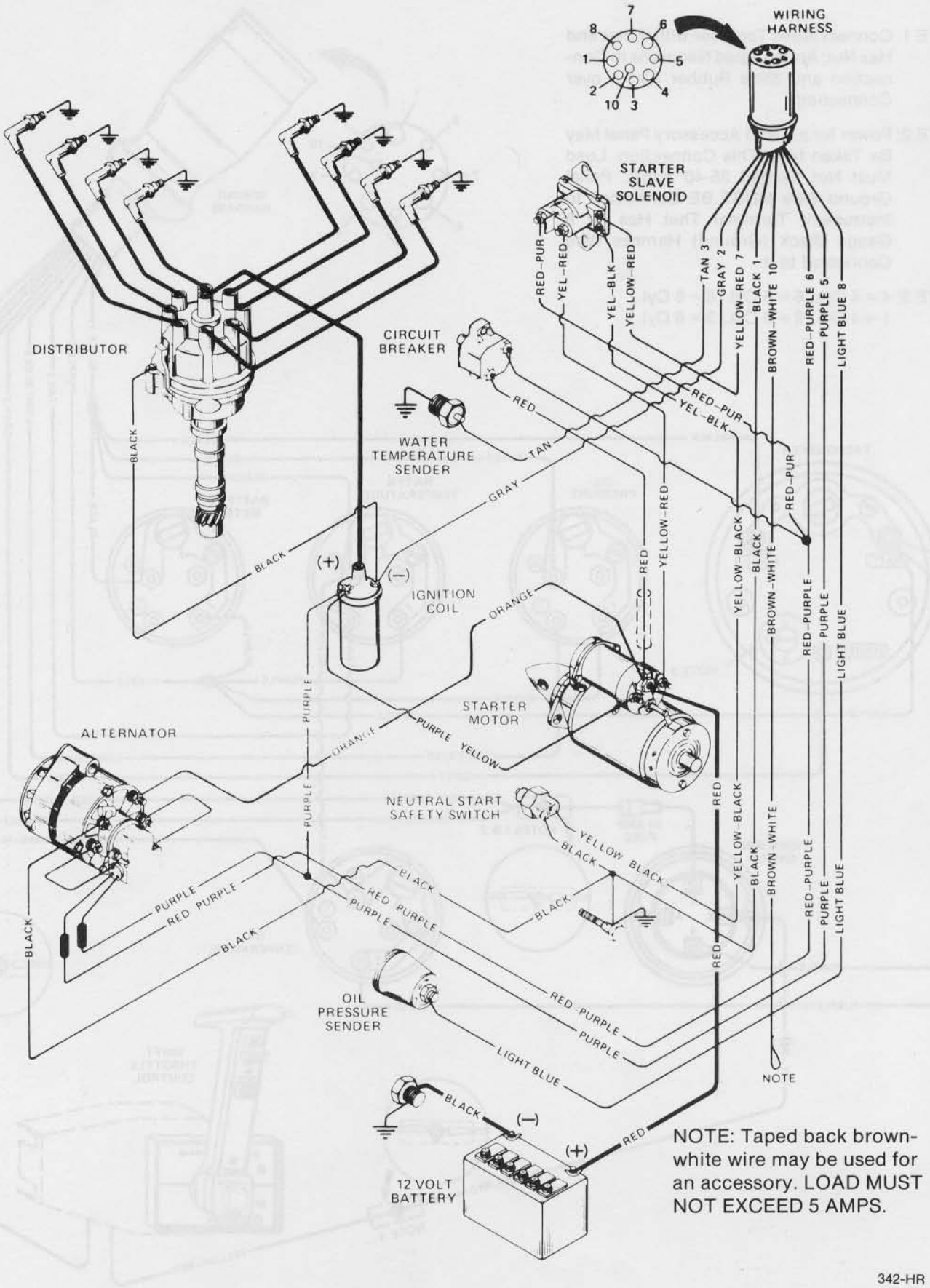
895-H


7
8
6
1
5
2
4
10
3
RED/PUR
YEL
BLK
YEL/RED
TAN 3
GRY 2
YEL/RED 7
BLK 1
BRN/WHT 10
RED/PUR 6
PUR 5
LIT BLU 8
ELECTRIC CHOKE
RED
WHT/RED
WHT/GRN
GRY
PUR
RED
(+)
(−)
WATER TEMPERATURE SENDER
TAN
RED/PUR
RED
OIL PRESSURE SWITCH
RED
ORN
YEL
RED
NEUTRAL START SAFETY SWITCH
BLK
BLK
BLK
ORN
BLK
PUR
RED/PUR
OIL PRESSURE SENDER
LIT BLU
BRN/WHT
BLK
(−)
(+)
RED
AUDIO WARNING SYSTEM
TO 12 VOLT SOURCE
PUR
AUDIO WARNING BUZZER (On Dash)
PUR
WATER TEMPERATURE HEAT SWITCH (On Engine)
TAN/BLU
TAN/BLU
TRANS. FLUID HEAT SWITCH (On Engine)
OIL PRESSURE SWITCH (On Engine)
TAN/BLU



454 Magnum, 7.4 Litre (Bravo One Drive)

1058-H

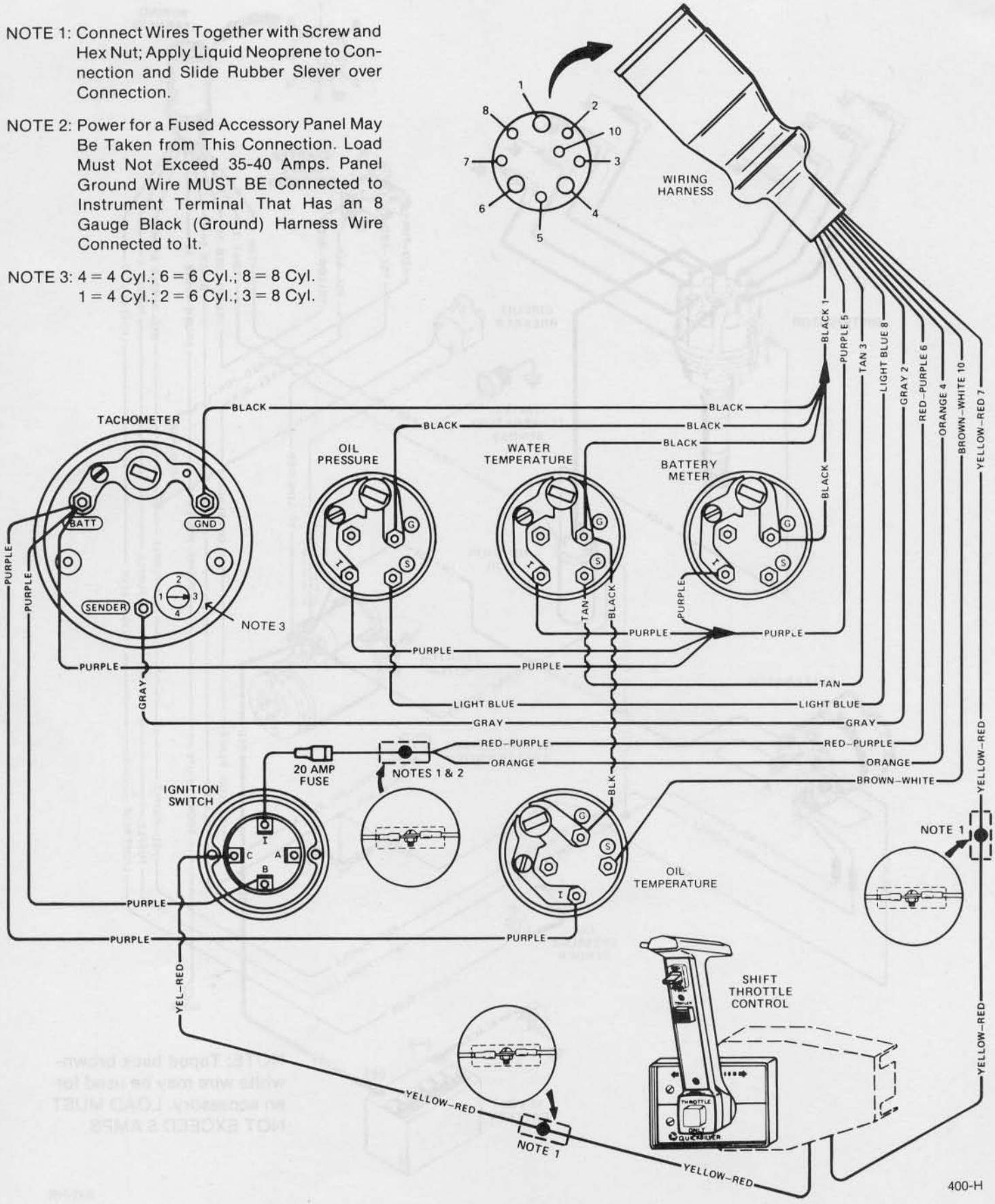


MIE 5.7 Ski Engine

NOTE 1: Connect Wires Together with Screw and Hex Nut; Apply Liquid Neoprene to Connection and Slide Rubber Slever over Connection.

NOTE 2: Power for a Fused Accessory Panel May Be Taken from This Connection. Load Must Not Exceed 35-40 Amps. Panel Ground Wire MUST BE Connected to Instrument Terminal That Has an 8 Gauge Black (Ground) Harness Wire Connected to It.

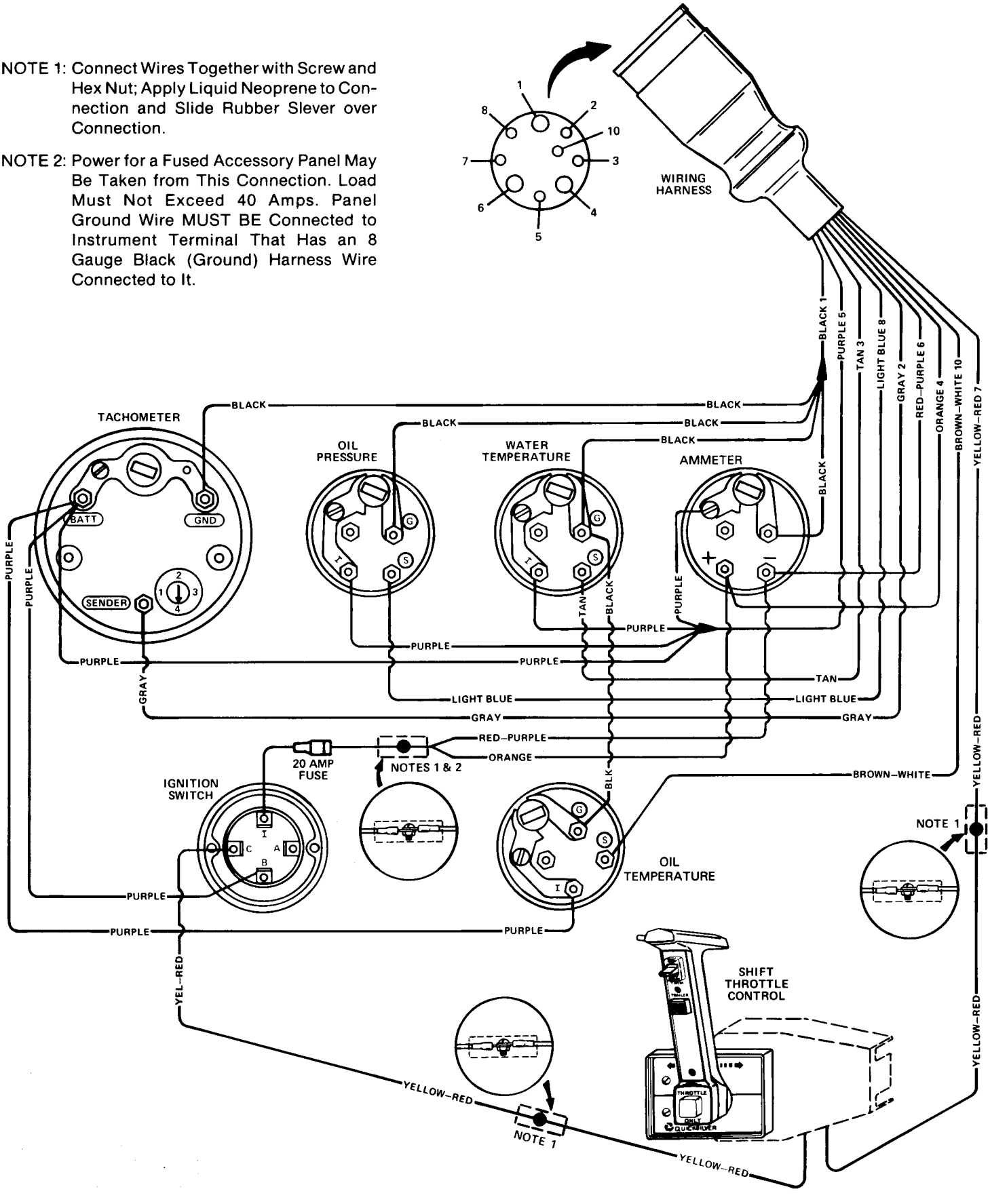
NOTE 3: 4 = 4 Cyl.; 6 = 6 Cyl.; 8 = 8 Cyl.
1 = 4 Cyl.; 2 = 6 Cyl.; 3 = 8 Cyl.



Instrument Wiring with Battery Meter Circuit

NOTE 1: Connect Wires Together with Screw and Hex Nut; Apply Liquid Neoprene to Connection and Slide Rubber Slever over Connection.

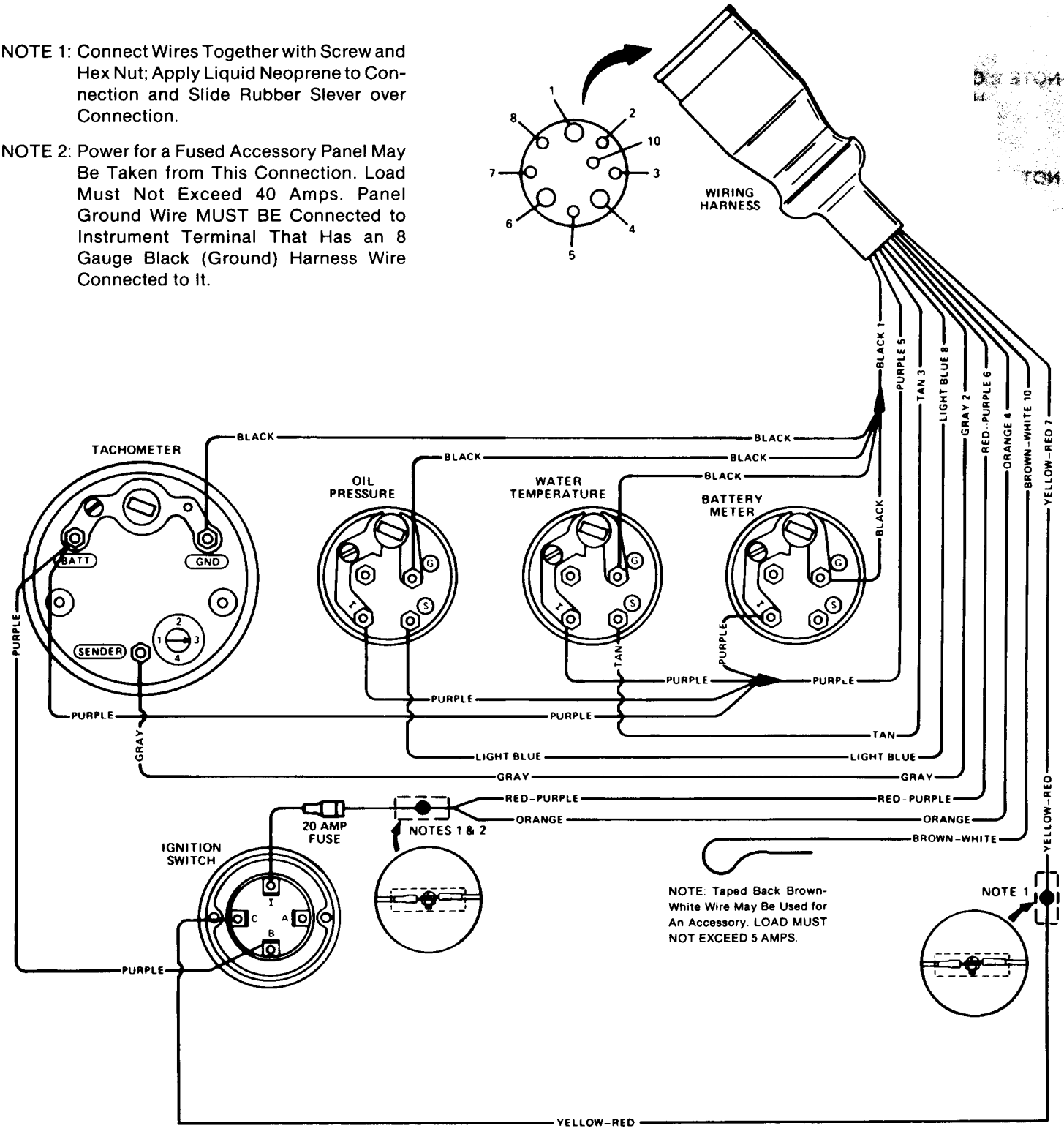
NOTE 2: Power for a Fused Accessory Panel May Be Taken from This Connection. Load Must Not Exceed 40 Amps. Panel Ground Wire MUST BE Connected to Instrument Terminal That Has an 8 Gauge Black (Ground) Harness Wire Connected to It.



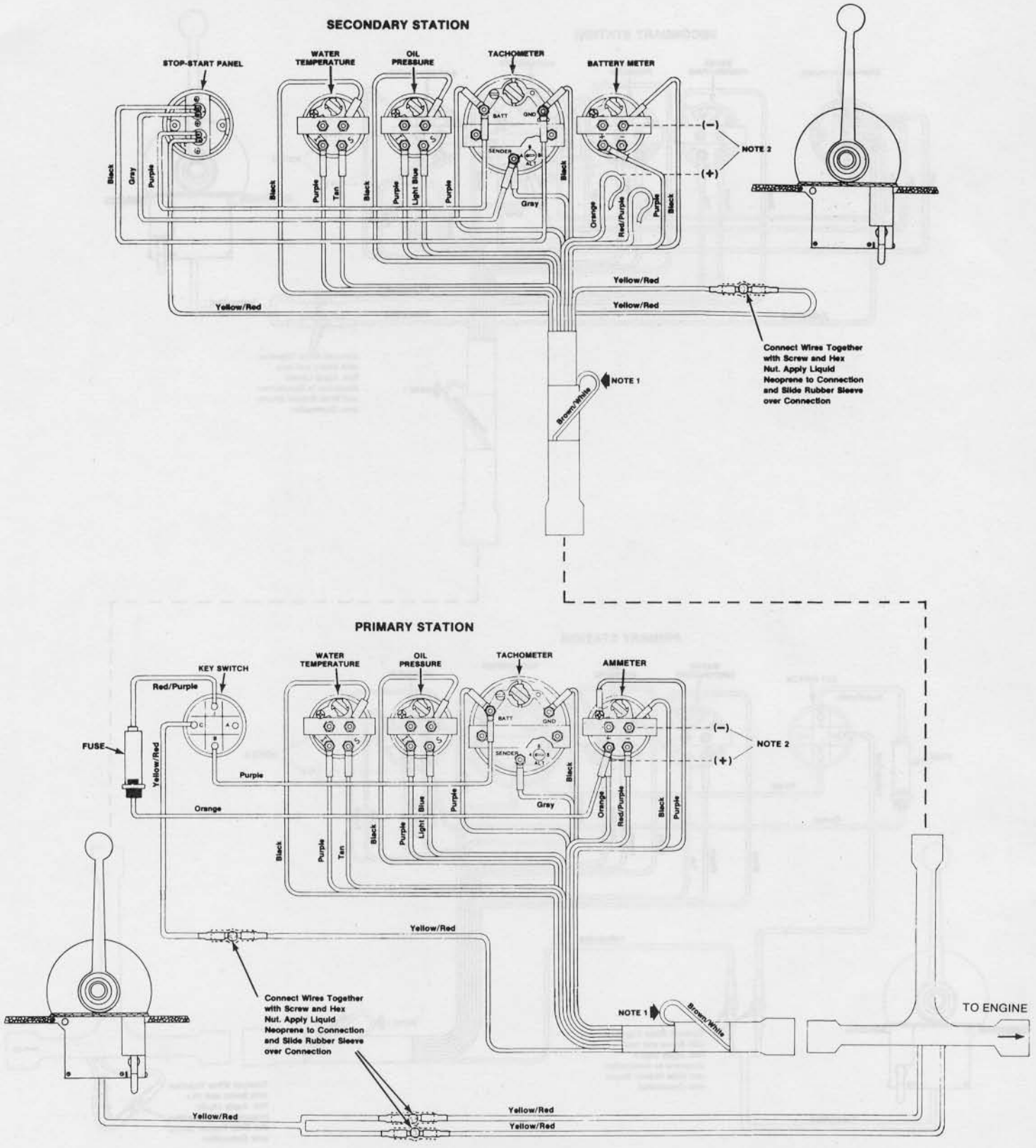
Instrument Wiring with Ammeter Circuit

NOTE 1: Connect Wires Together with Screw and Hex Nut; Apply Liquid Neoprene to Connection and Slide Rubber Slever over Connection.

NOTE 2: Power for a Fused Accessory Panel May Be Taken from This Connection. Load Must Not Exceed 40 Amps. Panel Ground Wire MUST BE Connected to Instrument Terminal That Has an 8 Gauge Black (Ground) Harness Wire Connected to It.



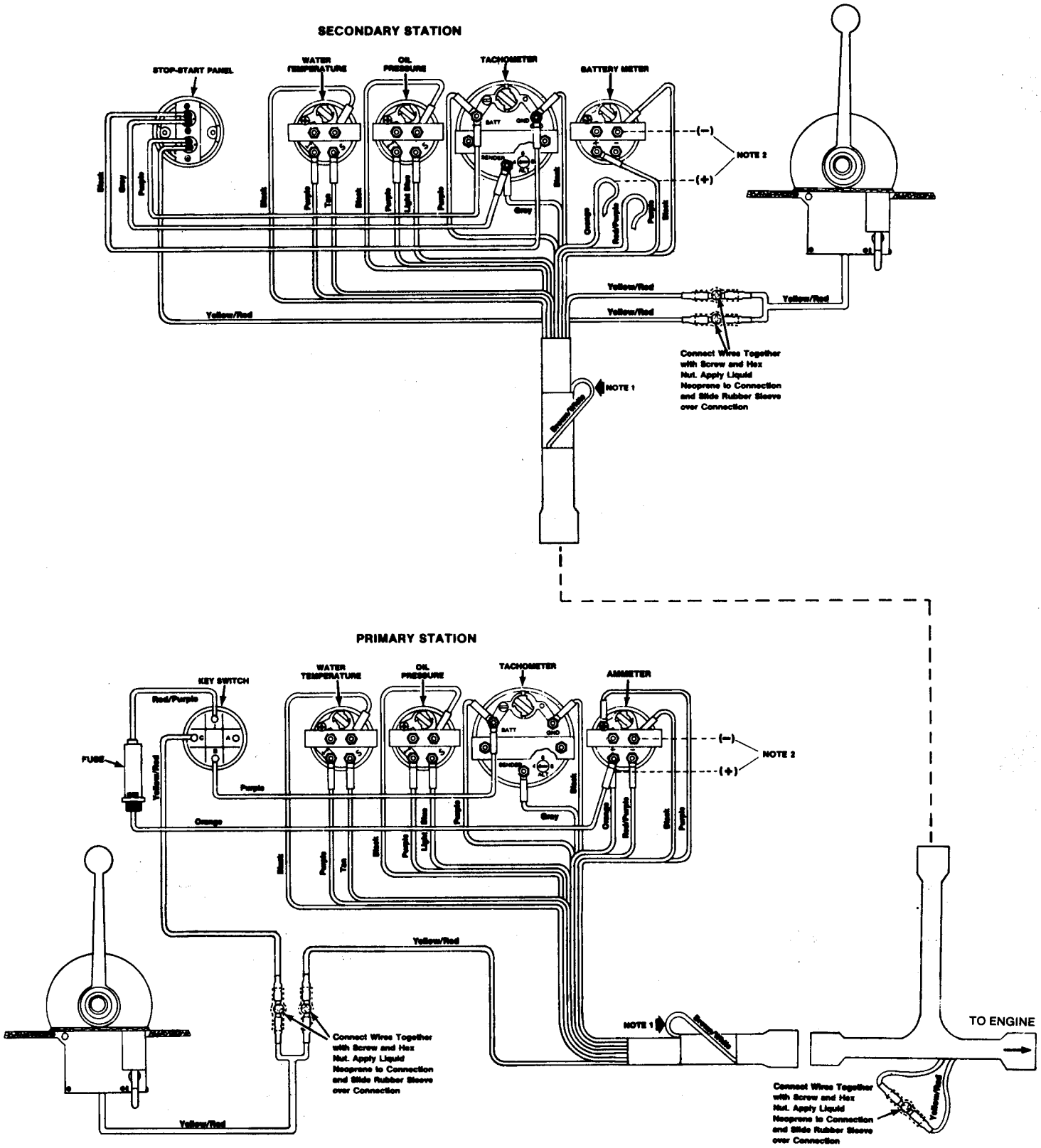
Instrument Wiring MIE 5.7L Ski



NOTES: 1. Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).

2. An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.

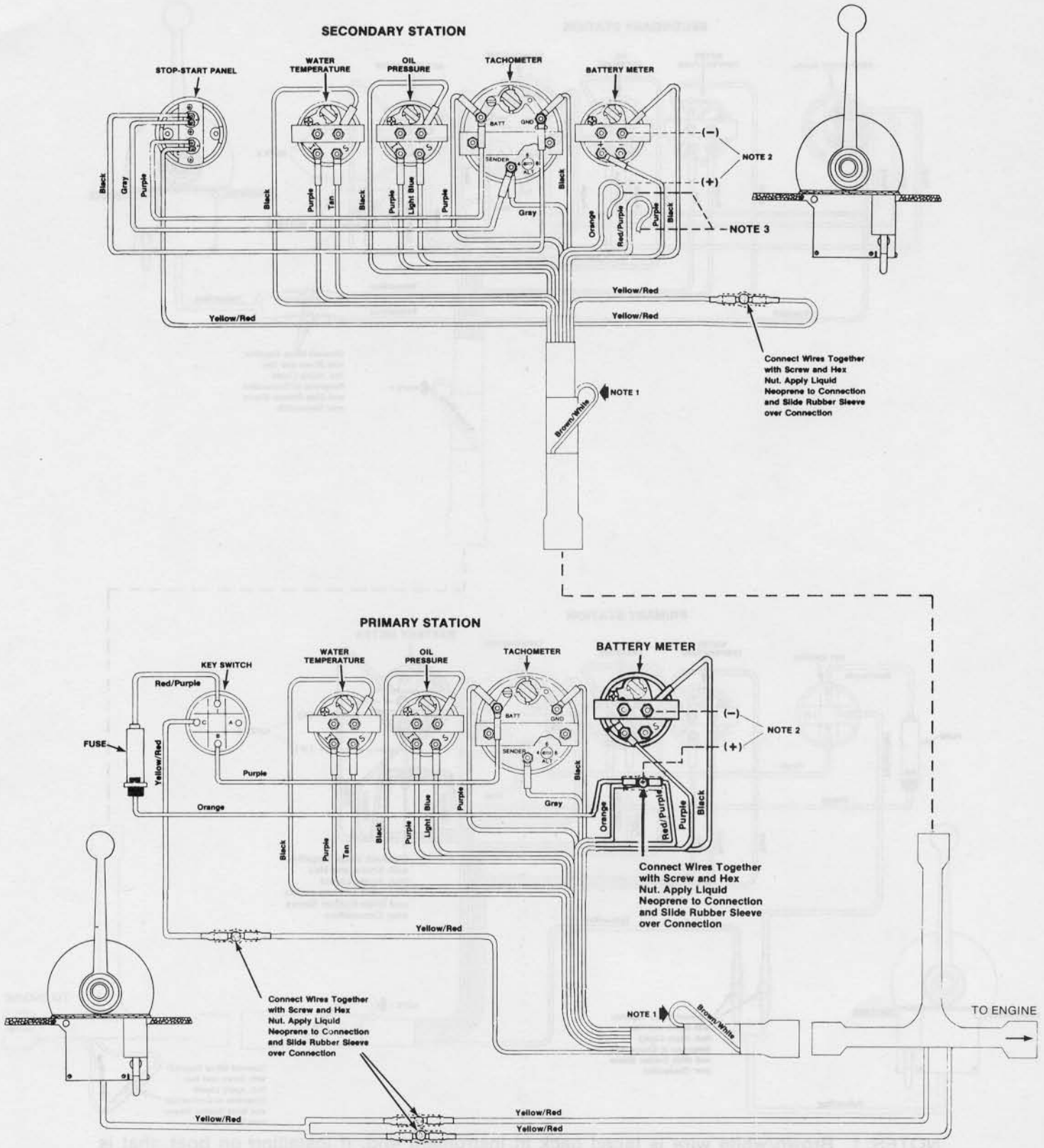
Dual Station Wiring
Using a Neutral Safety Swtich in Only One Remote Control
(Ammeter Circuit)



NOTES: 1. Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).

2. An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.

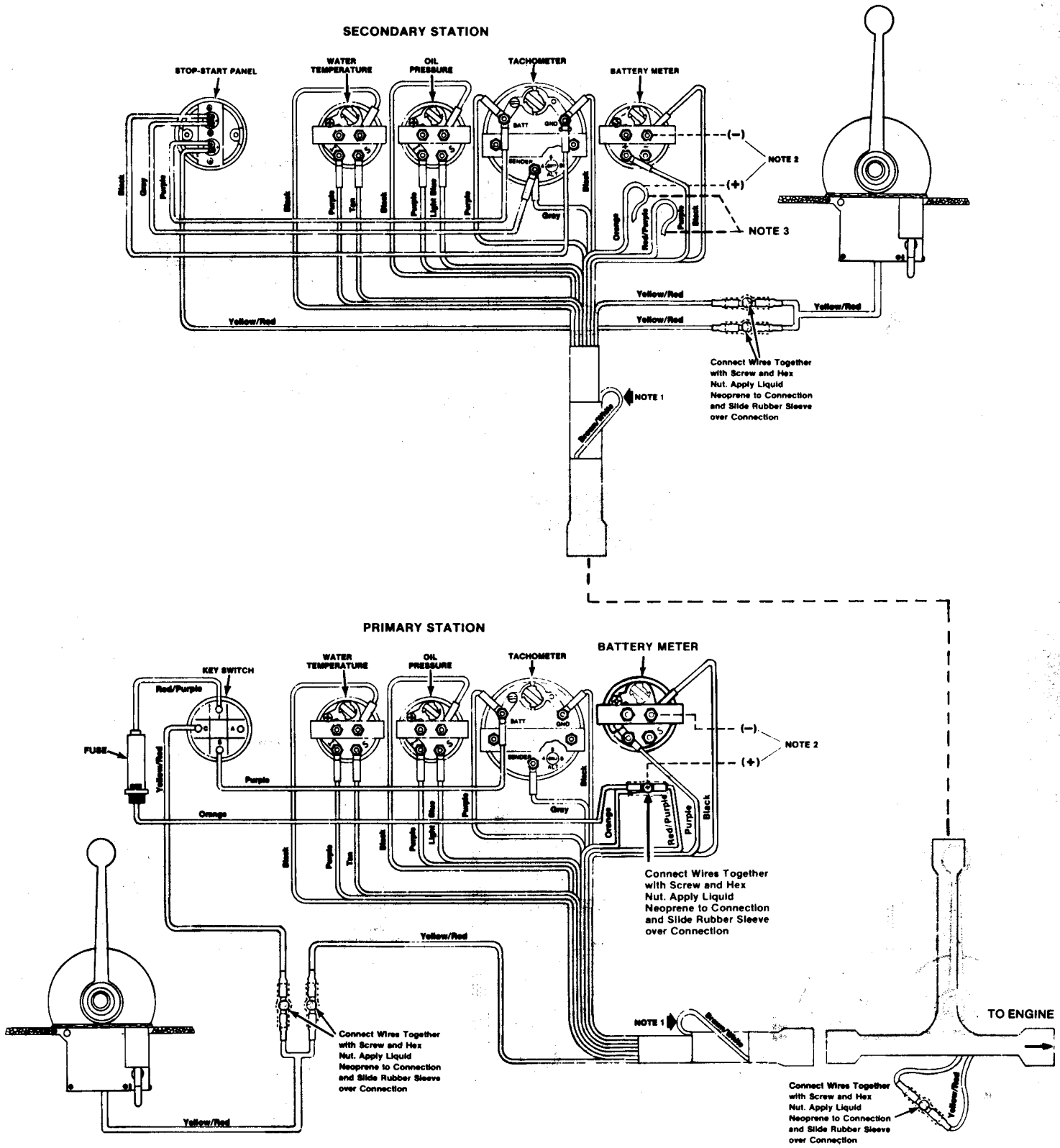
Dual Station Wiring
Using a Neutral Safety Swtich in Both Remote Control
(Ammeter Circuit)



NOTES: 1. Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).

2. An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.
3. Tape back and insulate with at least 4 layers of electrical tape.

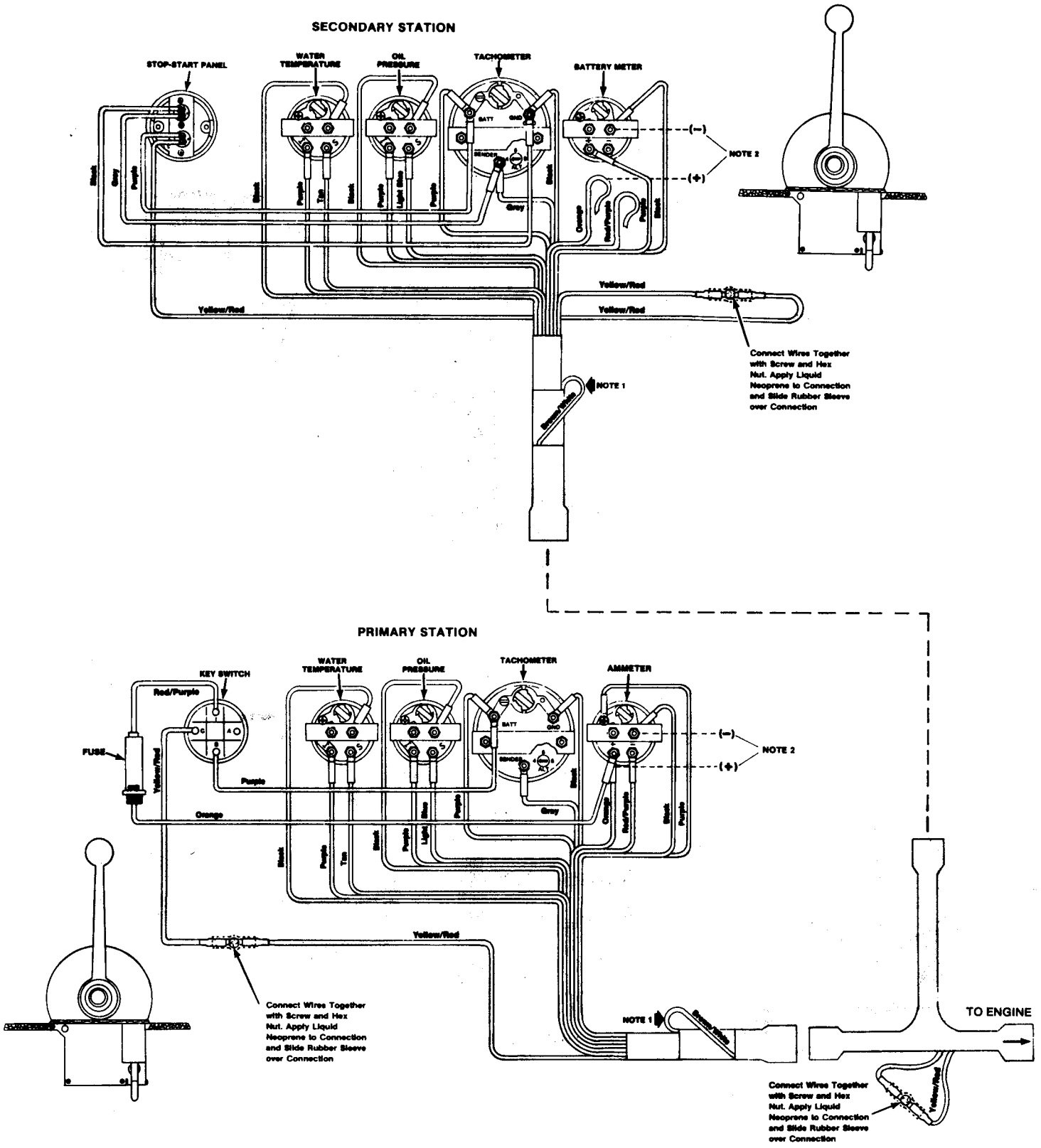
Using a Neutral Safety Swtich in Only One Remote Control (Battery Meter Circuit)



NOTES: 1. Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).

2. An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.
3. Tape back and insulate with at least 4 layers of electrical tape.

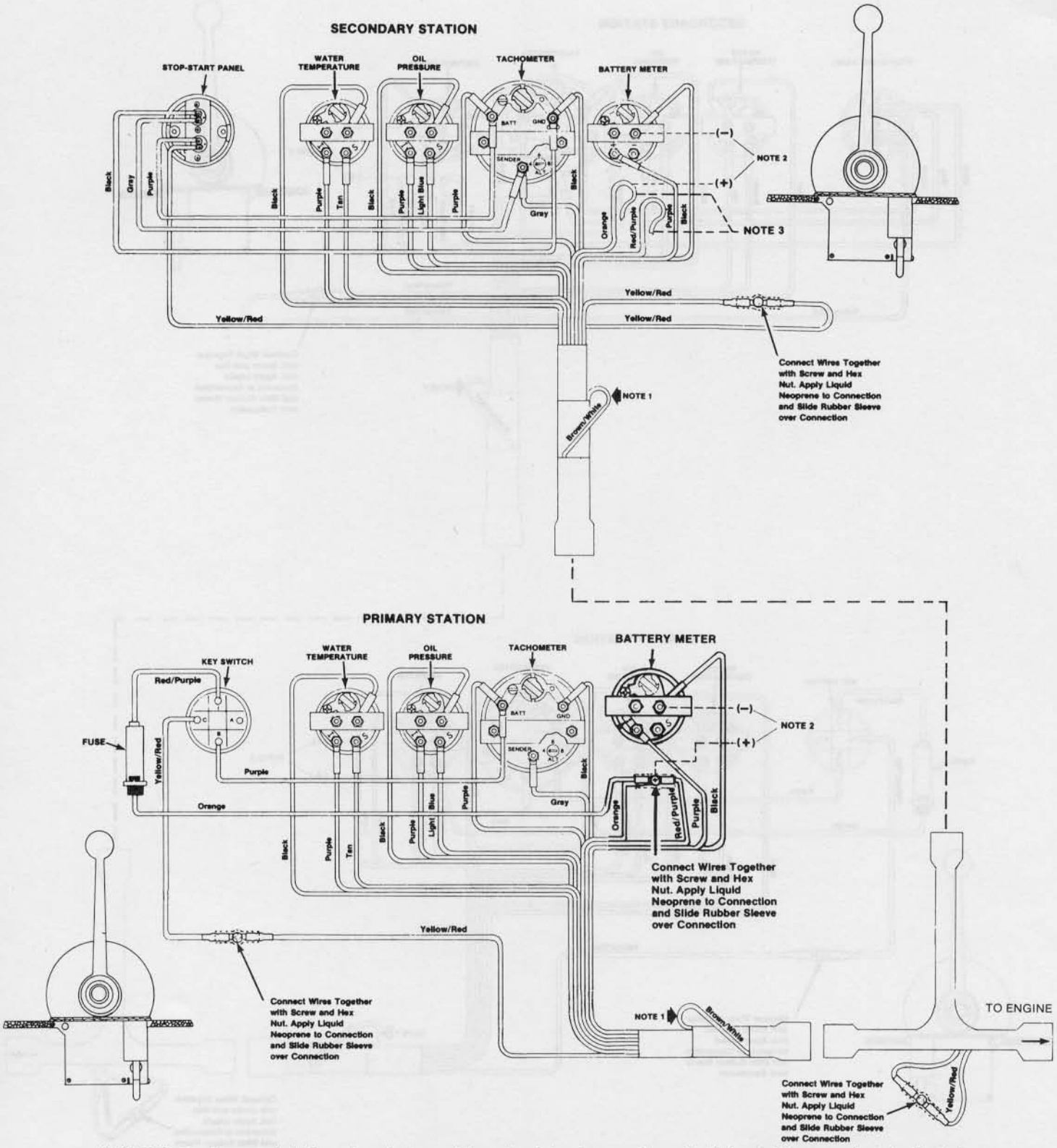
Dual Station Wiring
Using a Neutral Safety Switch in Both Remote Controls
(Battery Meter Circuit)



NOTES: 1. Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).

2. An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.

Dual Station Wiring with
Neutral Safety Swtich in Engine Wiring Harness
(Ammeter Circuit)

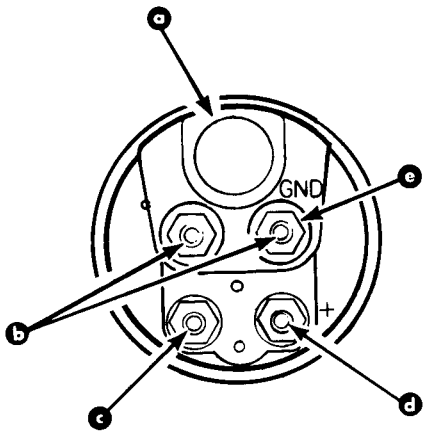


NOTES: 1. Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).

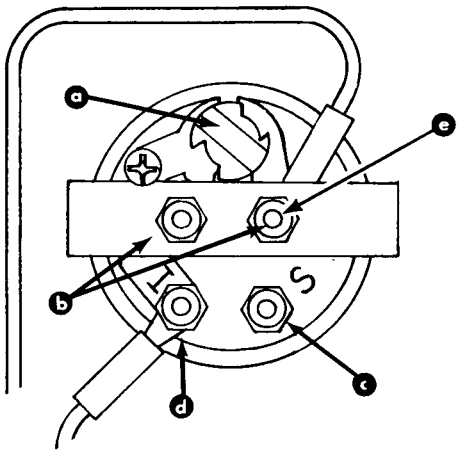
2. An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.
3. Tape back and insulate with at least 4 layers of electrical tape.

Dual Station Wiring with
Neutral Safety Swtich in Engine Wiring Harness
(Battery Meter Circuit)

BATTERY METER GAUGES



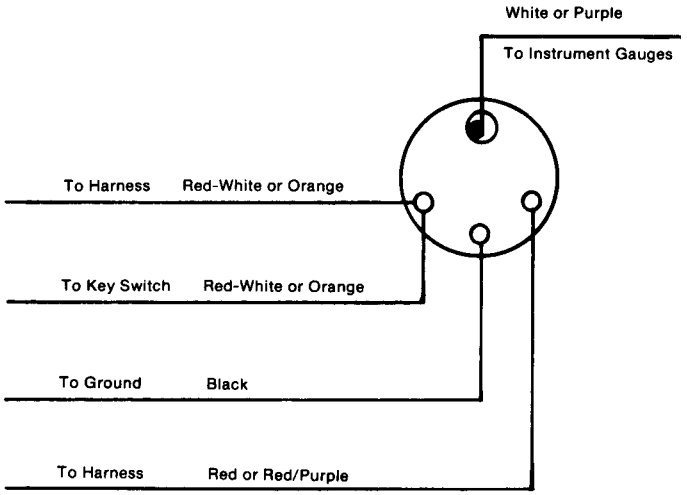
EARLY STYLE



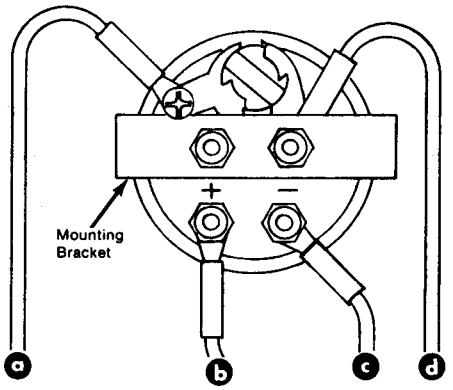
LATER STYLE

a - Lamp Mounting Hole
b - Gauge Mounting Studs
c - Terminal Not Used
d - Purple (or White) Jumper Wire from This Terminal to I (or +) Terminal on Water Temperature or Oil Pressure Gauge
e - Black Jumper Wire from This Terminal to Ground Terminal on Water Temperature or Oil Pressure Gauge

AMMETER GAUGES



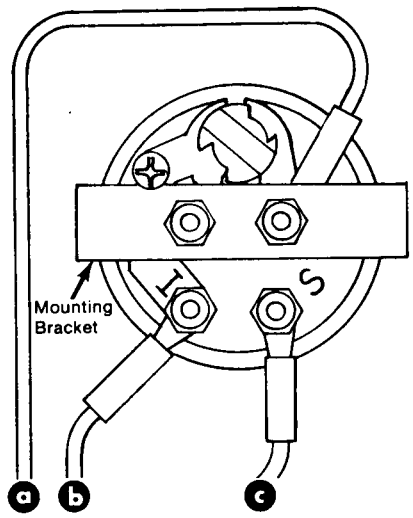
EARLY STYLE



LATER STYLE

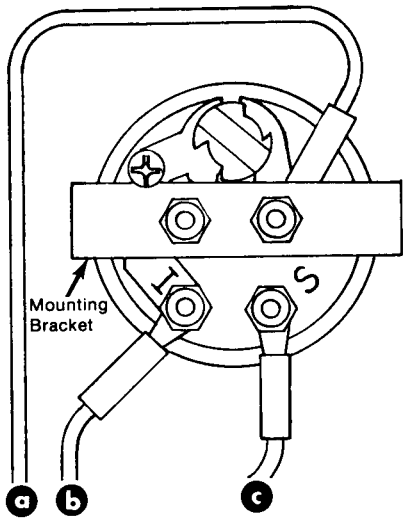
Pre BIA Color Code	BIA Color Code	Leads to —
a. White Wire Jumper (Supplied in Kit) That Is Connected to Nearest 12-Volt Supply	a. Purple Wire	a. To 12-Volt Switched Terminal on Adjacent Gauge or to Accessory Side of Ignition Switch
b. Red with White Stripe Wire	b. Orange Wire	b. To "Batt" Side of Alternator
c. Red Wire	c. Red with Purple Stripe Wire	c. To Battery or to "Batt" Side of Starter Solenoid
d. Black Wire	d. Black Wire	d. To Ground

WATER TEMPERATURE GAUGE



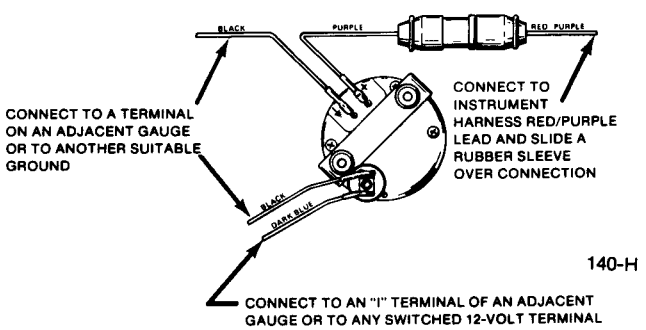
Pre BIA Color Code	BIA Color Code	Leads to —
a. Black Wire	a. Black	a. Ground
b. White Wire	b. Purple	b. Switched 12-Volt Terminal
c. Green Wire	c. Tan	c. Sender Lead

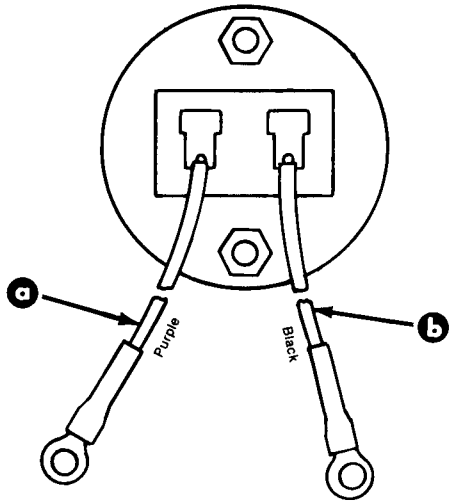
OIL PRESSURE GAUGE



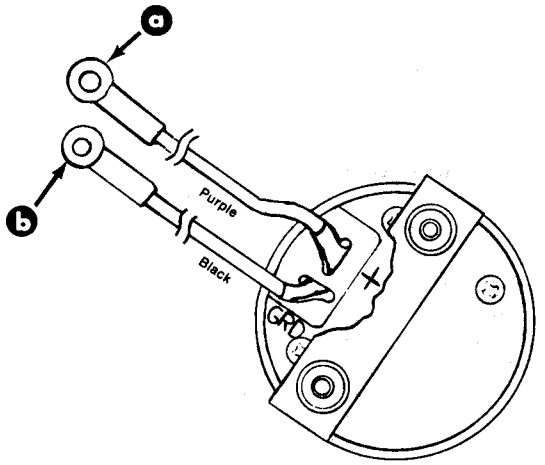
Earlier Model MerCruiser Color Code	BIA Color Code	Leads to —
(a) Black Wire	(a) Black	(a) Ground
(b) White Wire	(b) Purple	(b) Switched 12-Volt Terminal
(c) Orange Wire	(c) Light Blue	(c) Sender Lead

CLOCK





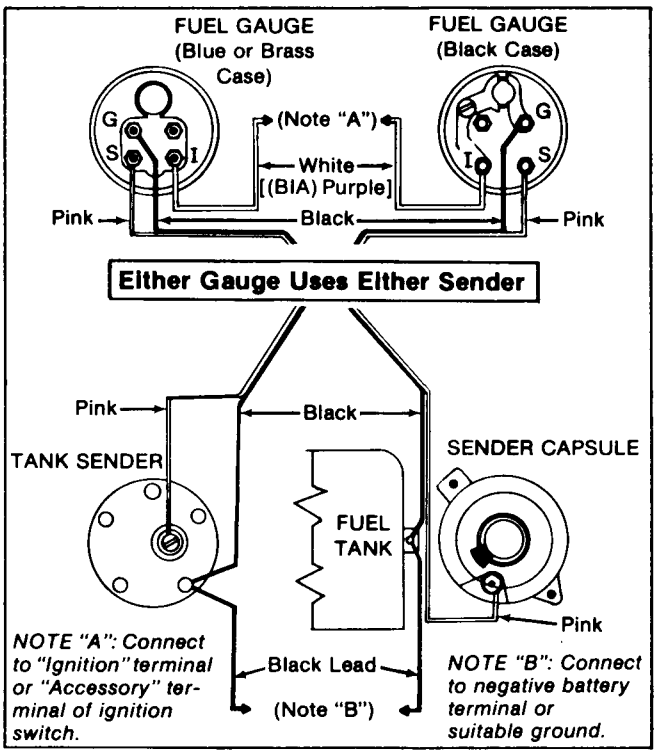
EARLY STYLE



LATER STYLE

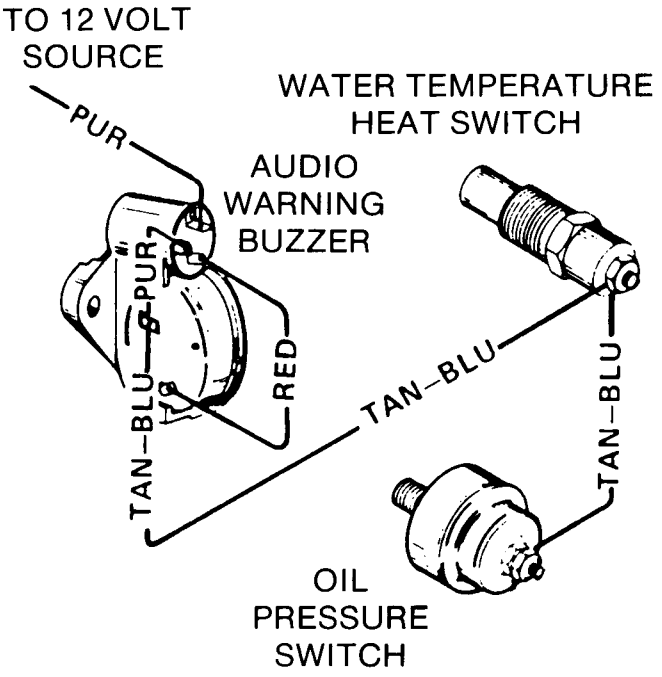
a - Connect to ignition switch activated 12-volt positive (+) source
b - Connect to negative (-) ground

FUEL GAUGE AND SENDER

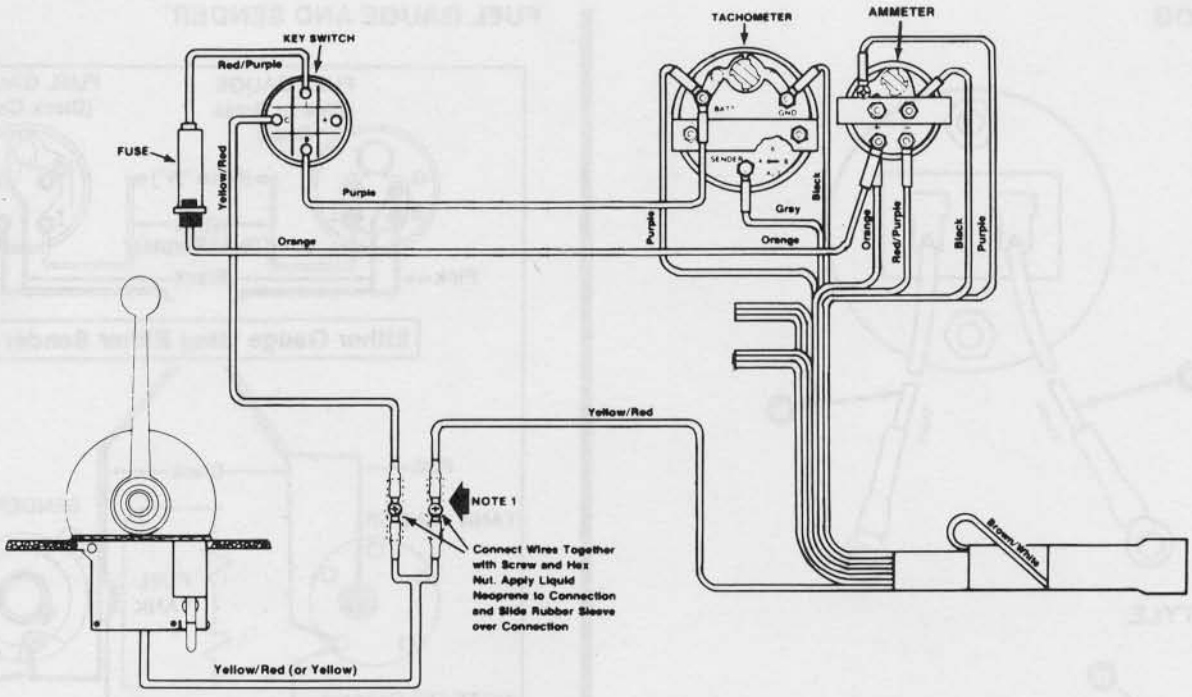


⚠WARNING

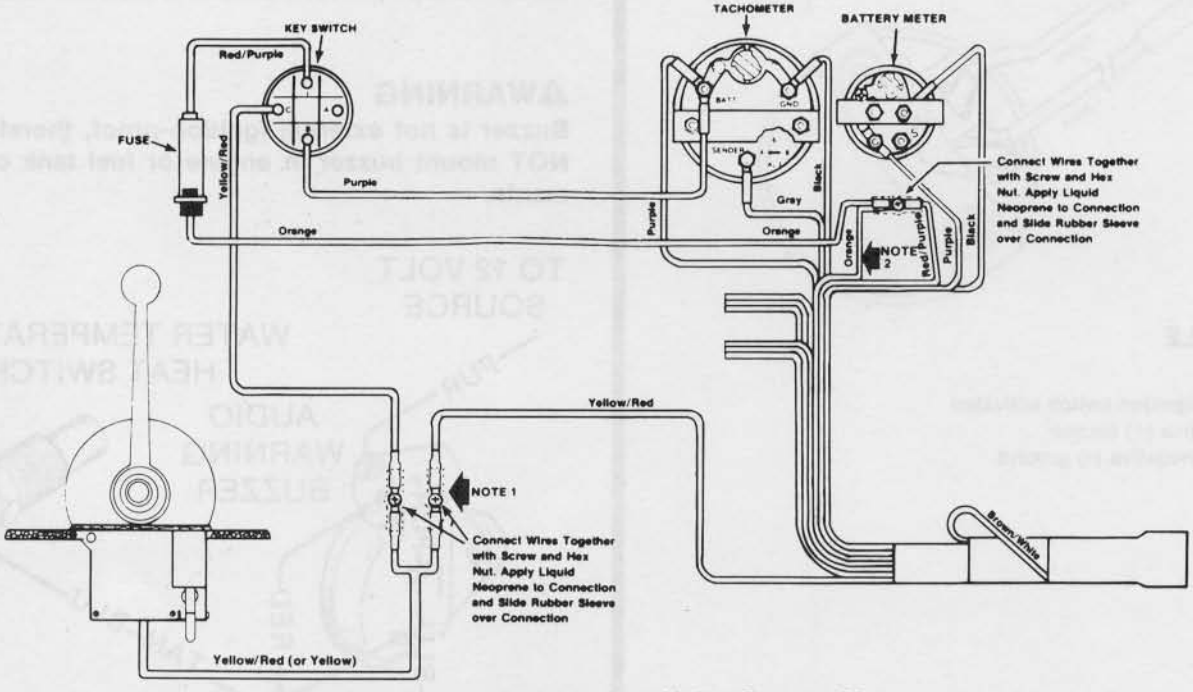
Buzzer is not external ignition-proof, therefore, DO NOT mount buzzer in engine or fuel tank compartments.



Audio Warning System Wiring Diagram



Key Switch Installation when Using Ammeter and BIA Color-Coded Wiring Harness.



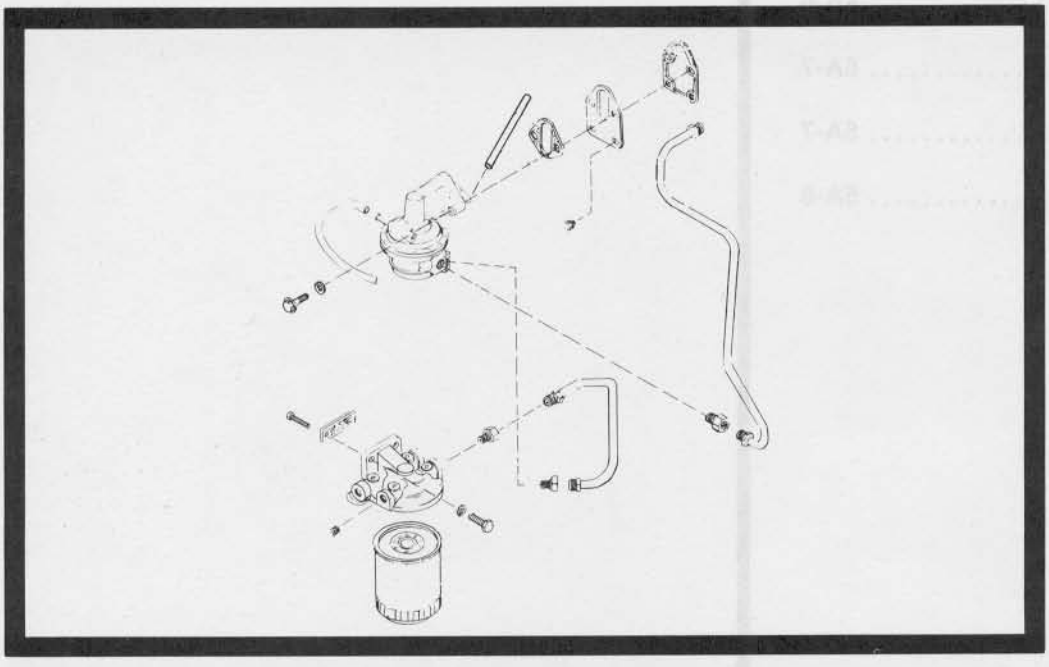
Key Switch Installation when Using Battery Meter and BIA Color-Coded Wiring Harness

⚠CAUTION

Neutral start safety switch MUST BE USED in cranking circuit. If remote control does not incorporate this switch, it must be part of engine wiring.

NOTE 1: If engine is equipped with a neutral safety switch (on the engine or transmission), connect yellow/red ignition switch wire directly to yellow/red wiring harness wire with screw, nut and sleeve. A neutral safety switch MUST BE used in starting circuit to prevent accidental starting of engine when in gear.

FUEL SYSTEM



FUEL DELIVERY SYSTEM and FUEL PUMPS

5

A

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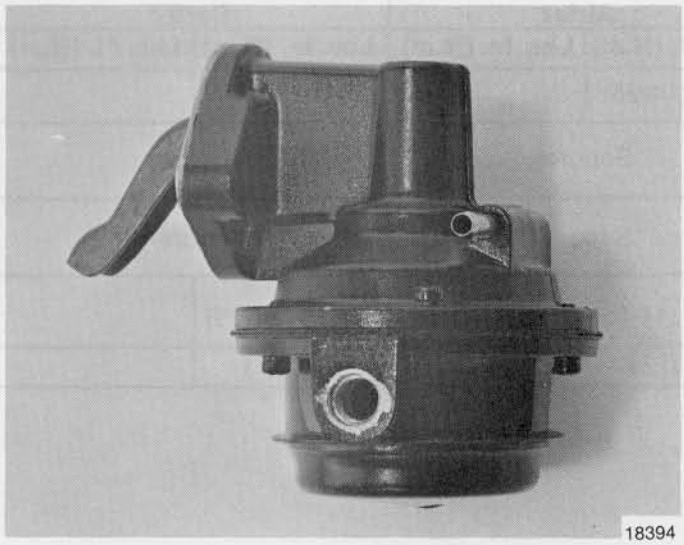
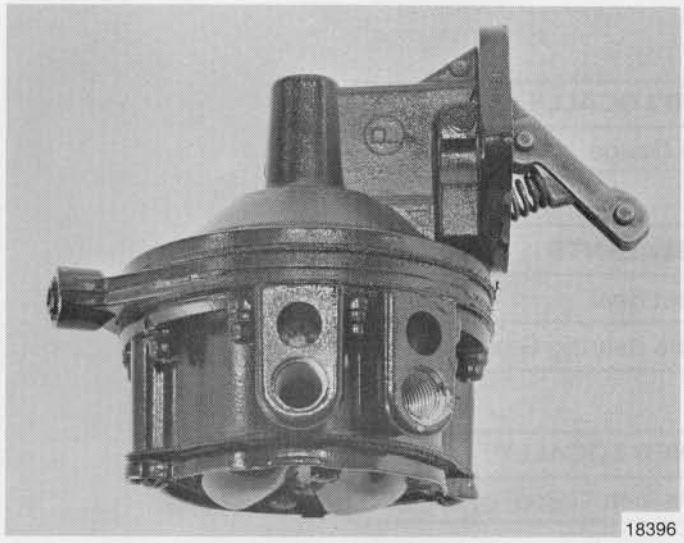
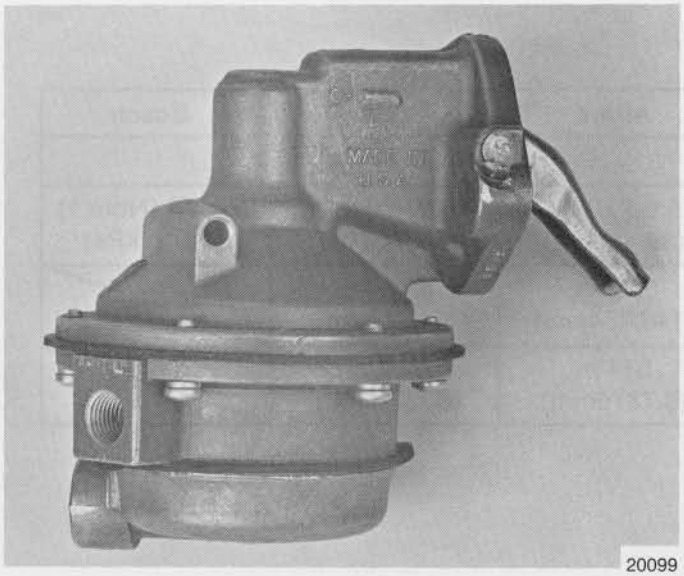
Identification



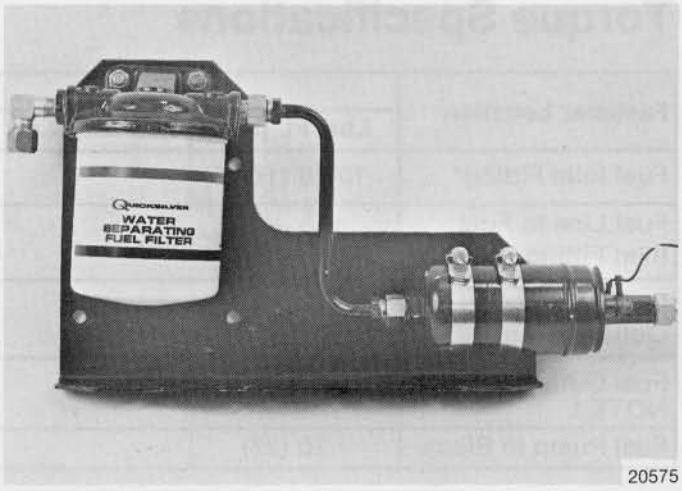
Airtex Pump



AC Pump (Dual Diaphragm)



Carter Pump



EFI Bosch Electric Pump

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	AC		Airtex		Carter	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)
Fuel Inlet Fitting*	10-18 (14-25)		10-18 (14-25)		10-18 (14-25)	
Fuel Line to Fuel Inlet Fitting	Securely		Securely		Securely	
Fuel Line to Fuel Outlet Fitting	Securely		Securely		Securely	
Fuel Outlet Fitting NOTE 1	10-18 (14-25)		10-18 (14-25)		10-18 (14-25)	
Fuel Pump to Block	20 (27)		20 (27)		20 (27)	

*NOTE 1: Coat fuel line inlet and outlet fitting threads with Loctite Pipe Sealant with Teflon, DO NOT use teflon tape. Torque to specifications.

Tools/Lubricants/Sealants

TOOLS OBTAINED LOCALLY
Fuel Pressure Gauge

LUBRICANTS/SEALANTS	
92-34227	Quicksilver Perfect Seal
92-42649	Quicksilver Needle Bearing Gasket

SEALANTS OBTAINED LOCALLY
Loctite Pipe Sealant with Teflon

Specifications

Type of Fuel Pump	AC	Airtex	Carter	Bosch
Pump Pressure (1000 RPM)				
Pump Pressure (1800 RPM)	5.25-6.5 PSI (36-44 kPa)	5.5-7.0 PSI (38-48 kPa)	5.25-6.5 PSI (36-44 kPa)	39 PSI (Note 1) (267.5 kPa)
Push Rod Length	5.76 in. (146.304mm)	5.76 in. (146.304mm)	5.76 in. (146.304mm)	
Push Rod Movement	.344 in. (8.7376mm)	.344 in. (8.7376mm)	.344 in. (8.7376mm)	

NOTE 1: Refer to EFI Troubleshooting for testing pump with complete EFI system.

Precautions

⚠WARNING
ALWAYS disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING
Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filters. Wipe up any spilled fuel immediately.

⚠WARNING
Make sure that no fuel leaks exist, before closing engine hatch.

⚠CAUTION
DO NOT operate engine without cooling water being supplied to seawater pickup pump or pump impeller will be damaged, and subsequent overheating damage may result.

Fuel Delivery System

Recommendations

⚠WARNING
Boating industry standards (BIA, ABYC, etc.) federal standards and Coast Guard regulations MUST BE adhered to when installing fuel delivery system.

When designing and installing fuel delivery system, the following information MUST BE observed:

1. Fuel tank should be mounted below carburetor level, if possible. If tank is mounted above carburetor level, gravity feed may cause carburetor fuel inlet needle to unseat, and flooding may result.
2. Fuel pickup should be at least 1" (25mm) from the bottom of the fuel tank to prevent picking up water or other impurities.
3. Fuel lines used MUST BE Coast Guard approved (USCG type A) and MUST NOT BE SMALLER THAN 3/8" (9.5mm) I.D. 1/4" (6.4mm) I.D. EFI return line. On installations where long lines or numerous fittings are required, larger size lines should be used.
4. Fuel line should be installed free of stress and firmly secured to prevent vibration and/or chafing.
5. Sharp bends in fuel line should be avoided.
6. A flexible fuel line must be used to connect fuel line to engine to absorb deflection when engine is running.

Description

The fuel system consists of a fuel tank(s), a water separating fuel filter (if so equipped), a fuel pump, and a carburetor.

The fuel is stored in the fuel tank. When the engine is cranking or running, fuel is drawn from the fuel tank, through the water separating filter (if so equipped), by a mechanically operated fuel pump. The fuel pump is operated by the engine camshaft.

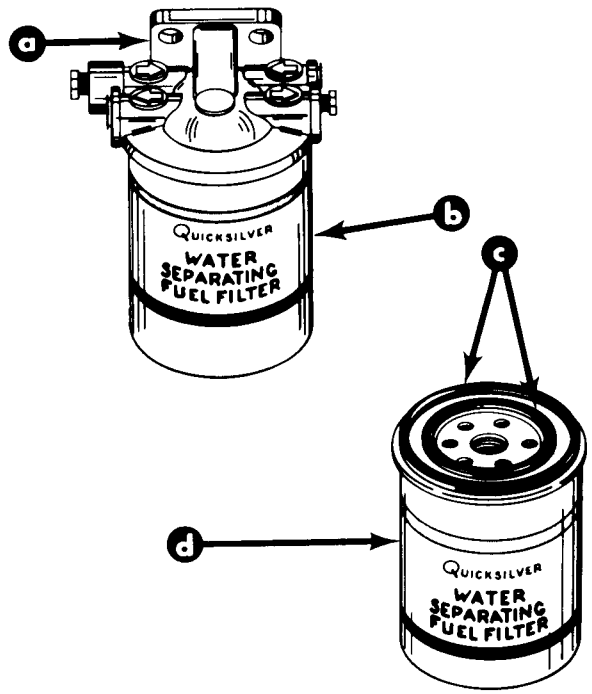
The fuel is pushed through the fuel pump to the carburetor where it is metered and fed to the engine.

Water Separating Fuel Filter

NOTICE
Refer to "Precaution", in this section, BEFORE proceeding.

The water separating fuel filter is standard on some engines and can also be purchased as an option for engines not equipped with it.

The fuel filter consists of the fuel filter base and filter element.

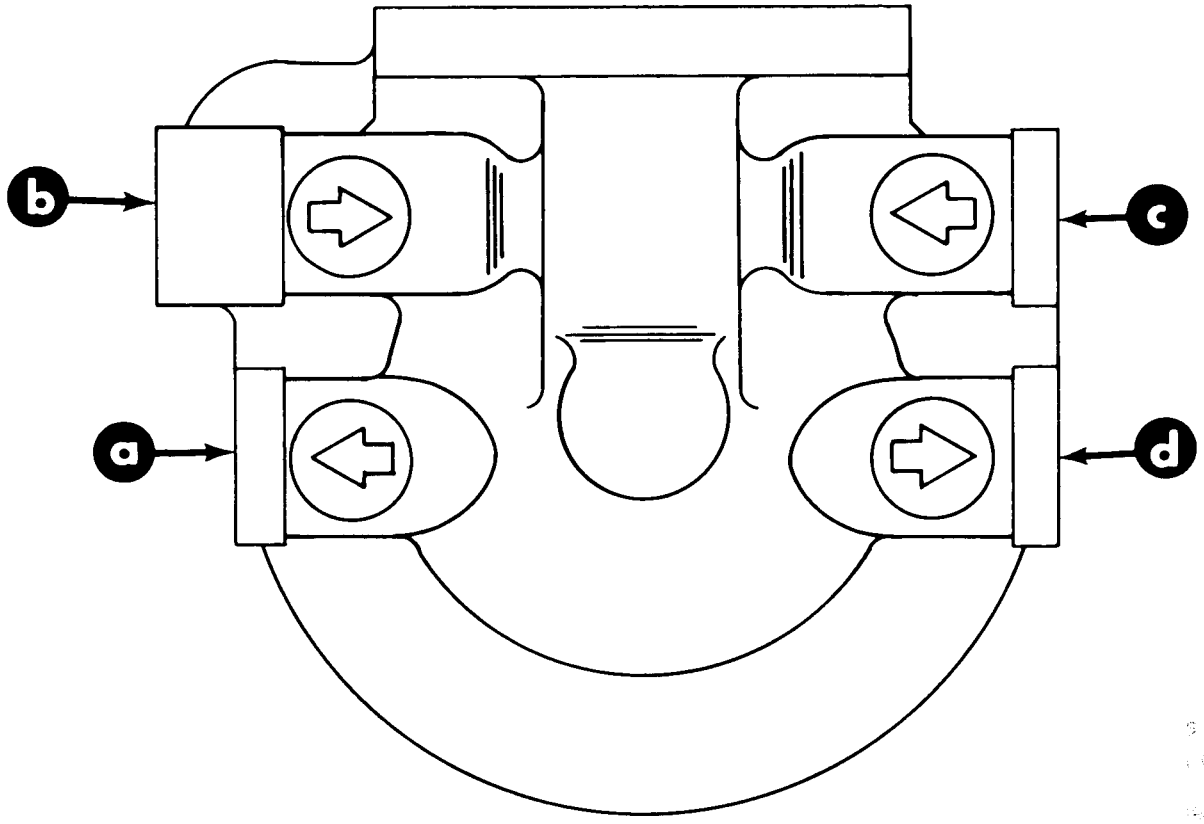


a - Filter Mounting Base
b - Filter Element
c - Sealing Rings
d - Replacement Element

IMPORTANT: If installing water separating fuel filter as an option, filter should be located between fuel tank and fuel pump. Also fuel inlet and outlet lines must be connected correctly for filter to work properly. Follow instructions supplied with water separating fuel filter kit.

⚠CAUTION

Coat fuel line fitting threads with either Loctite No. 69 hydraulic sealant or Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.



a - Fuel Outlet if "C" is the Inlet
b - Fuel Inlet if "D" is the Outlet
c - Fuel Inlet if "A" is the Outlet
d - Fuel Outlet if "B" is the Inlet

Replacement

1. Disconnect negative and positive battery leads from battery.
2. Remove filter element from mounting base by turning counterclockwise. You may need a filter wrench to break element loose.

IMPORTANT: Element cannot be cleaned and reused, it must be replaced.

a - Remove Old Filter
b - Lubricate Sealing Rings with Engine Oil
c - Install New Filter (Tighten Securely By Hand Only)

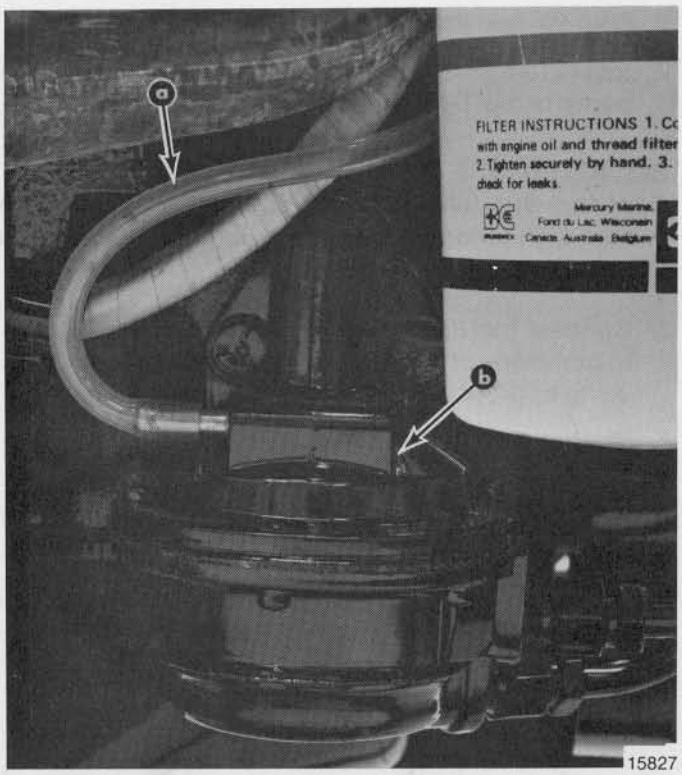
Replacing Water Separating Fuel Filter

3. Lubricate sealing rings with SAE engine oil.
4. Install new element. Tighten securely by hand.
5. Start engine (making sure water is supplied to cooling system) and check for fuel leaks.

Sight Tube

Inspection

Fuel pumps are equipped with a sight tube. Evidence of fuel in the sight tube indicates a ruptured diaphragm and fuel pump must be replaced immediately.



a - Sight Tube
b - Fuel Pump

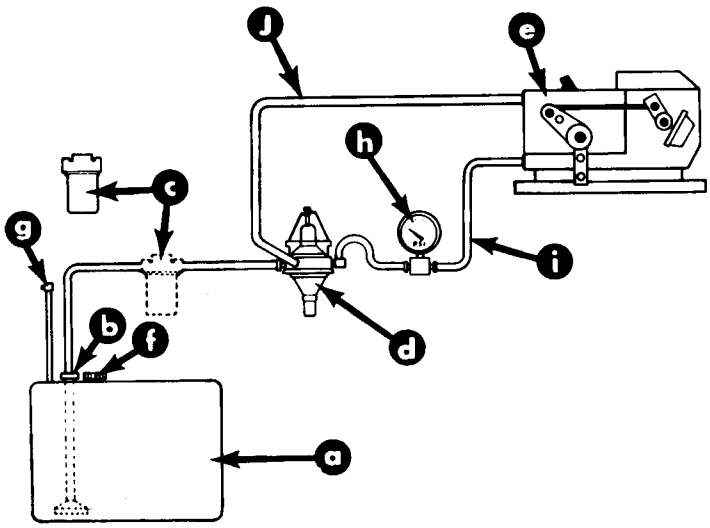
Testing Fuel Pump

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove fuel line from outlet side of fuel pump.
2. Install fuel pressure test gauge to outlet side of fuel pump using T-fitting and appropriate adaptors.

⚠CAUTION
Coat fuel line inlet fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

3. Connect fuel line (previously removed from pump) to other side of T-fitting on fuel pressure test gauge using appropriate adaptors.
4. Start engine and run at R.P.M. listed in specifications.
5. Fuel pressure should be within specifications. If not, repair or replace fuel pump.
6. Remove fuel pressure gauge and adaptors. Reconnect fuel line to fuel pump. Tighten to specifications.



a - Fuel Tank
b - Anti-Siphon Valve
c - Water Separating Fuel Filter (Optional)
d - Fuel Pump
e - Carburetor
f - Fuel Filler
g - Vent Hose
h - Pressure Test Gauge
i - Fuel Line
j - Sight Tube

AC Pump (Dual Diaphragm)

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

IMPORTANT: The AC fuel pump cannot be repaired. If the fuel pump fails it must be replaced.

Replacement

1. Disconnect fuel inlet and outlet lines at fuel pump.

⚠CAUTION
Plug fuel lines after disconnecting from fuel pump to eliminate any chance of fuel siphoning into bilge.

2. Remove sight tube.
3. Remove 2 fuel pump mounting screws, pump and gasket.
4. Remove mounting plate bolts, mounting plate, gasket, and push rod.
5. Check push rod length. See Specifications.
6. Check push rod movement by installing push rod in engine, install a dial indicator against end of push rod, and turning engine over one complete revolution. Push rod should have total movement as shown in specifications.
7. Coat push rod with Quicksilver Needle Bearing Grease and install in engine.
8. Apply Perfect Seal to both sides of mounting plate gasket. Then, install gasket, plate, and mounting bolts. Tighten securely.
9. Apply Perfect Seal to both sides of fuel pump gasket.
10. Install gasket, fuel pump and mounting bolts. Torque bolts to specifications.
11. Install fuel inlet and outlet fittings to fuel pump. Torque fittings to specifications. Tighten flare fittings securely.
12. Install sight tube.
13. Start engine and check for fuel leaks.

⚠CAUTION
Coat fuel line inlet fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

Airtex Pump

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

IMPORTANT: The Airtex pump cannot be repaired. If the fuel pump fails it must be replaced.

Replacement

1. Remove fuel inlet and outlet lines at fuel pump.

⚠CAUTION
Plug fuel lines after disconnecting from fuel pump to eliminate any chance of fuel siphoning into bilge.

2. Remove sight tube.
3. Remove 2 fuel pump mounting screws, pump, and gasket.
4. Remove mounting plate bolts, mounting plate, gasket, and push rod.
5. Check push rod length. See Specifications.
6. Check push rod movement by installing push rod in engine, install a dial indicator against end of push rod, and turning engine over one complete revolution. Push rod should have total movement as shown in specifications.
7. Coat push rod with Quicksilver Needle Bearing Grease and install in engine.
8. Apply Perfect Seal to both sides of mounting plate gasket. Then, install gasket, plate, and mounting bolts. Tighten securely.
9. Apply Perfect Seal to both sides of fuel pump gasket.
10. Install gasket, fuel pump and mounting bolts. Torque bolts to specifications.
11. Install fuel inlet and outlet fittings to fuel pump. Torque fittings to specifications. Tighten flare fittings securely.
12. Install sight tube.
13. Start engine and check for fuel leaks.

⚠CAUTION
Coat fuel line inlet fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

Carter Pump

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

IMPORTANT: The Carter pump cannot be repaired. If the fuel pump fails it must be replaced.

Replacement

1. Remove fuel inlet and outlet lines at fuel pump.

⚠CAUTION
Plug fuel lines after disconnecting from fuel pump to eliminate any chance of fuel siphoning into bilge.

2. Remove sight tube.
3. Remove 2 fuel pump mounting screws, pump, and gasket.
4. Remove mounting plate bolts, mounting plate, gasket, and push rod.
5. Check push rod length. See Specifications.
6. Check push rod movement by installing push rod in engine, install a dial indicator against end of push rod, and turning engine over one complete revolution. Push rod should have total movement as shown in specifications.
7. Coat push rod with Quicksilver Needle Bearing Grease and install in engine.
8. Apply Perfect Seal to both sides of mounting plate gasket then install gasket, plate, and mounting bolts. Tighten securely.
9. Apply Perfect Seal to both sides of fuel pump gasket.
10. Install gasket, fuel pump and mounting bolts. Torque bolts to specifications.
11. Install fuel inlet and outlet fittings to fuel pump. Torque fittings to specifications. Tighten flare fittings securely.
12. Install sight tube.
13. Start engine and check for fuel leaks.

⚠CAUTION
Coat fuel line inlet fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

Bosch Electric Pump

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

IMPORTANT: The Bosch fuel pump cannot be repaired. If the fuel pump fails it must be replaced.

Replacement

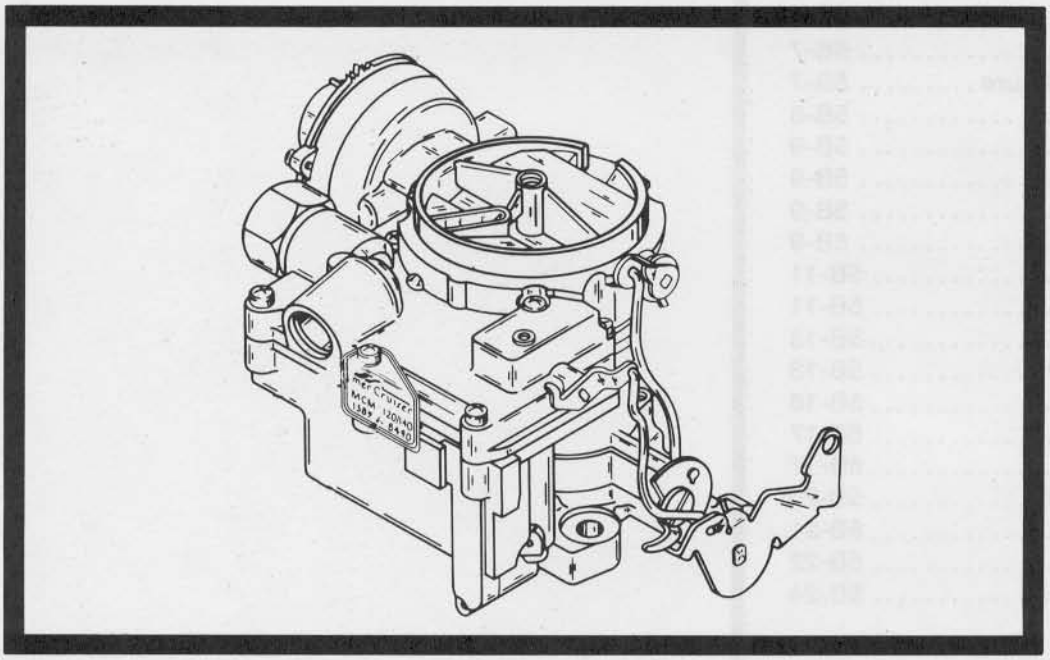
1. Disconnect fuel inlet and outlet lines at fuel pump.

⚠CAUTION
Plug fuel lines after disconnecting from fuel pump to eliminate any chance of fuel siphoning into bilge.

2. Remove all electrical leads.
3. Remove 2 fuel pump mounting clamps, and pump.
4. Install pump and pump mounting clamps. (Tighten securely.)
5. Install all electrical leads.
6. Connect fuel inlet and outlet lines.
7. Start engine and check for fuel leaks.

⚠CAUTION
Coat fuel line inlet fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

FUEL SYSTEM



MERCARB® 2 BARREL

5

B

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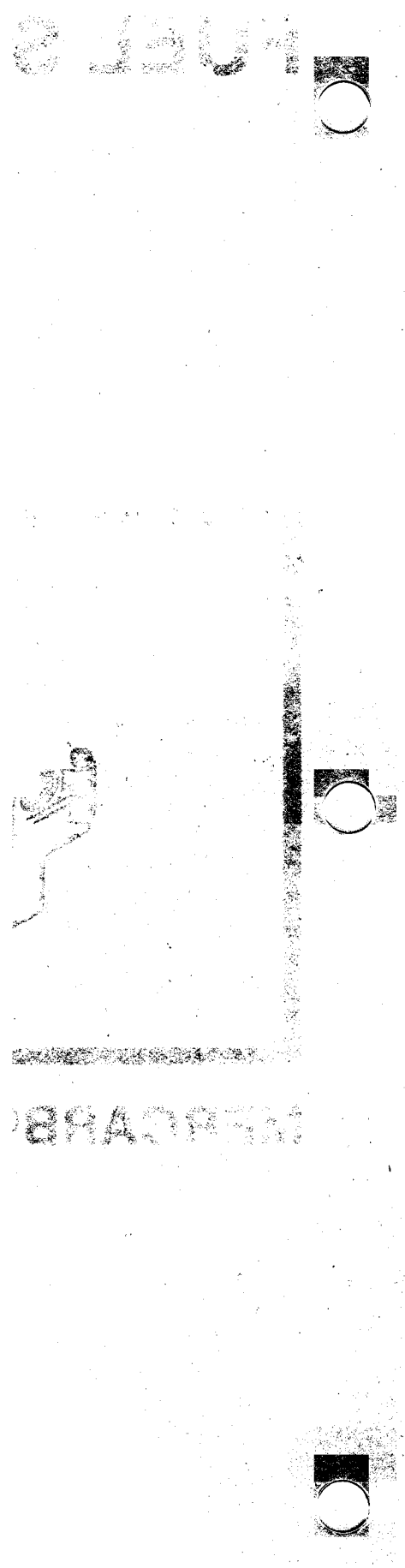
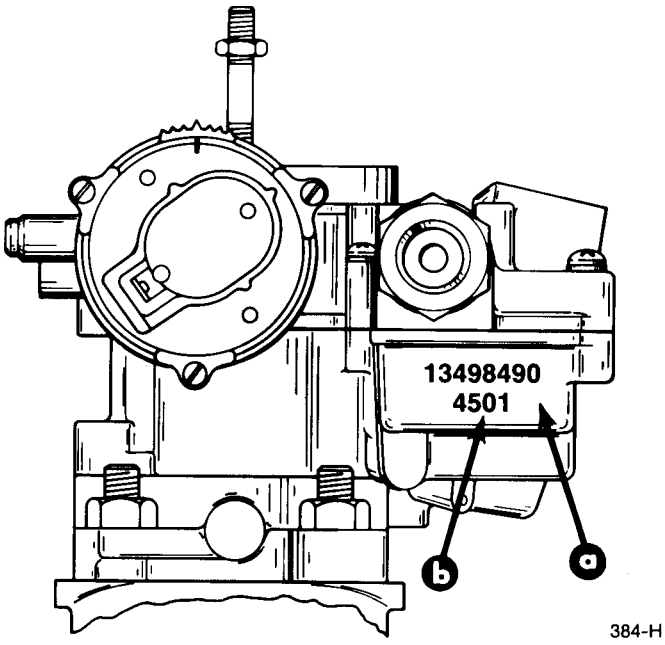


Identification



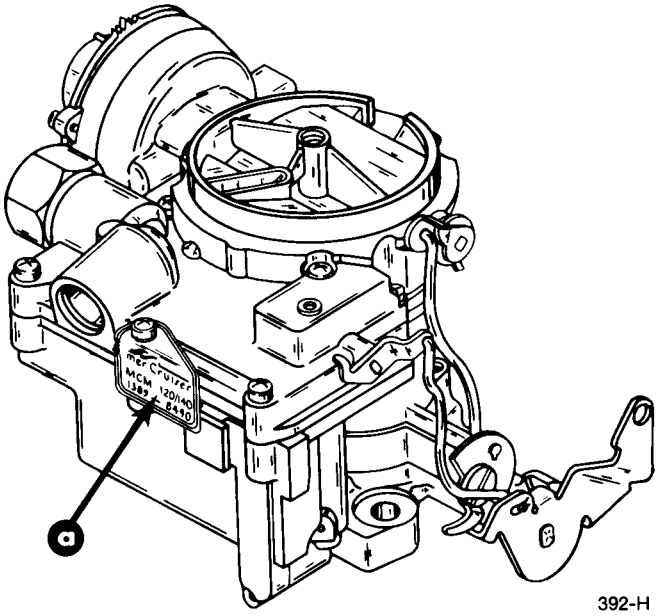
384-H

a - Part Number
b - Date Code

Carburetor Part Number Location

Date Code Expalnation: Example 4501

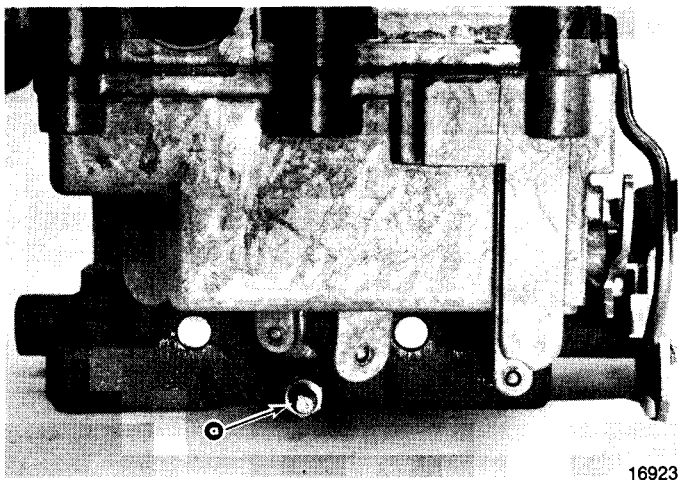
First Figure is Year
4 = 1984, 5 = 1985, etc.
Second Figure is Month
5 = May, 6 = June, 7 = July, etc.
X = October, Y = November, Z = December
Third and Fourth Figure is Day of Month
01 = First day, 02 = Second day, etc.



392-H

a - Part Number

Part Number Tag Location



16923

a - Single Idle Mixture Needle

MerCarb Carburetor

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)
Carburetor to Manifold	12 20 (27) (16)
Fuel Line to Carburetor	18 (24)
Fuel Inlet Filter Nut	18 (24)

Tools

MERCURY MARINE SPECIAL TOOLS	
91-59339	Tachometer
91-36392	Universal Carburetor Gauge

BORROUGHS TOOL and EQUIPMENT 2429 N. BURDICK ST. KALAMAZOO, MI 49007 (616) 345-5163	
BT 8128B	Float Gram Scale

Specifications

UNIT OF MEASUREMENT in. (mm)

CARBURETOR ADJUSTMENT SPECIFICATIONS (Note 1)

Engine Model	MCM 200	5.0 Litre
Carburetor Type	MerCarb® 35mm	
Carburetor Number	1389-8488A2	1389-9670
Float Level (Note 2)	5/8 (15.8)	
Float Drop (Note 2)	1-3/4 (44.5)	
Pump Rod	1-5/32 (29)	
Choke Setting	Index Marks Aligned	
Idle Mixture Screw Preliminary Setting	1-1/4 Turns	
Float Weight	9 Grams Max.	
Primary Jet Size	1.7mm	
Power Valve Size	1mm	

NOTES: 1. All measurements are ± 1/64" (.4mm). Information contained in this chart supercedes all service bulletins and service information printed in 1984 and earlier.

2. Measurement is taken from gasket. Fuel inlet needle is spring loaded. Before checking raise float and allow to fall by itself. **DO NOT FORCE downward by hand.**

Description

This MerCarb carburetor is a two bore carburetor and has a separate fuel feed for each venturi. This model also is equipped with an electric choke. A removable venturi cluster (secured to float bowl assembly) has the calibrated main well tubes and pump jets built into it. The venturi cluster is serviced as a unit. The serviceable main metering jets are fixed orifice type that work together with fixed air bleeds to properly meter the correct fuel/air mixture to the engine.

Precautions

⚠WARNING
Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING
Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING
Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING
Make sure no fuel leaks exist, before closing engine hatch.

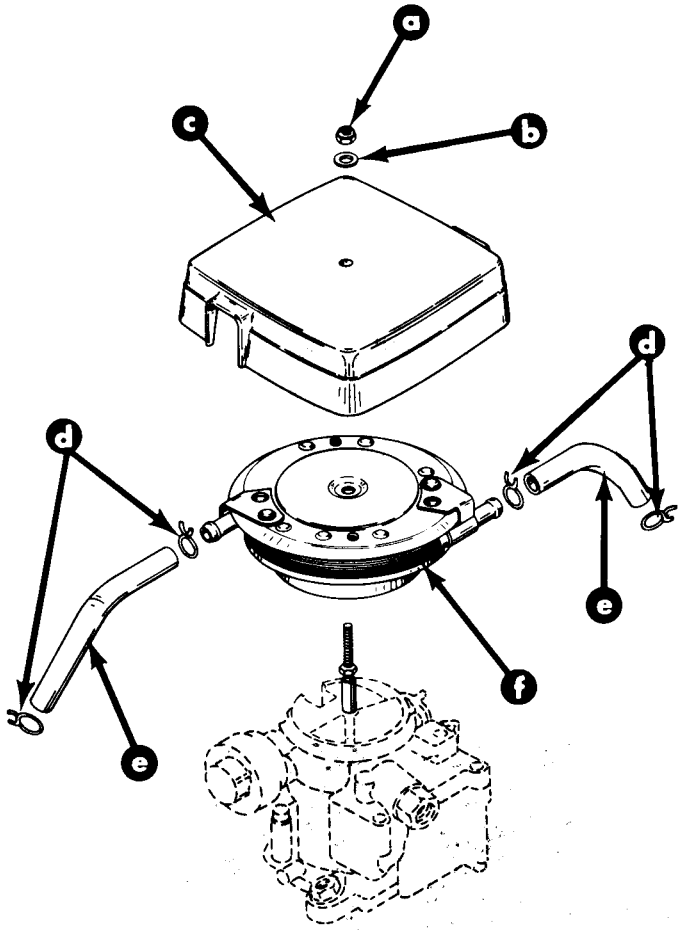
⚠CAUTION
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Maintenance

Flame Arrestor with Carburetor Cover

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove in the following order:
   a. Nut.
   b. Sealing washer.
   c. Carburetor cover.
   d. Hose clamps and crankcase ventilation hoses - From flame arrestor and rocker arm covers.
   e. Flame arrestor - Lift from carburetor.
2. Clean and inspect:
   a. Clean flame arrestor in solvent and blow dry with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.
3. Install in the following order:
   a. Flame arrestor - Place on carburetor.
   b. Crankcase ventilation hoses and hose clamps - To flame arrestor and rocker arm covers.
   c. Carburetor cover.
   d. Sealing washer.
   e. Nut - Tighten securely.



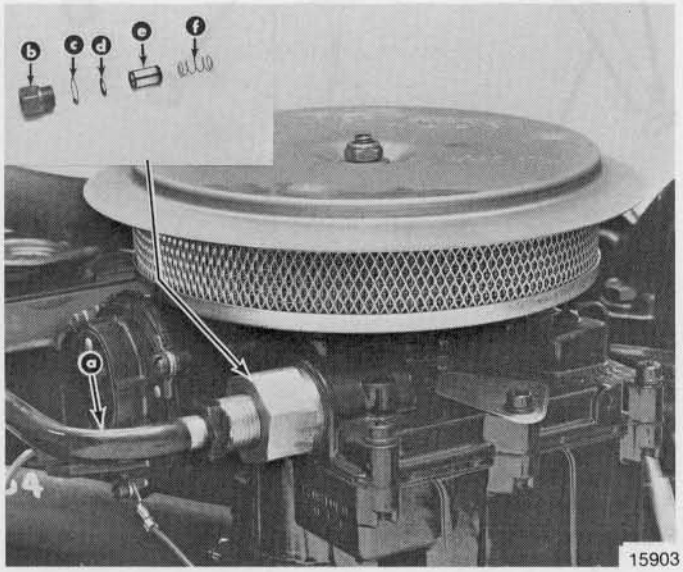
a - Nut
b - Washer
c - Carburetor Cover
d - Clamps
e - Crankcase Ventilation Hoses
f - Flame Arrestor

Flame Arrestor with Carburetor Cover

Fuel Inlet Filter

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove in the following order:
   a. Fuel line from fuel inlet filter nut.
   b. Fuel inlet filter nut.
   c. Large gasket.
   d. Filter.
   e. Spring.
   f. Small gasket - From inside filter nut.



a - Fuel Line
b - Fuel Inlet Filter Nut
c - Gasket (Large)
d - Gasket (Small)
e - Filter
f - Spring

Carburetor Fuel Inlet Filter

2. Clean filter nut and spring in solvent and dry with compressed air.
3. Install in the following order:
   a. Spring - Place in carburetor body.
   b. Filter - Open end to inlet filter nut.
   c. Small gasket - Place inside filter nut.
   d. Large gasket - Place over filter nut.
   e. Fuel inlet filter nut - Torque to specifications.
   f. Fuel line - Torque to specifications.

Choke Inspection

The choke does not require any periodic maintenance; however, if a choke malfunction is suspected, the following should be done:

1. With engine off, remove flame arrestor.
2. Open and close choke several times, and check for binding, loose or disconnected linkages, or other signs of damage.
3. If choke or linkage binds, sticks, or works sluggishly, clean with carburetor choke cleaner. Follow directions on can.

Adjustments

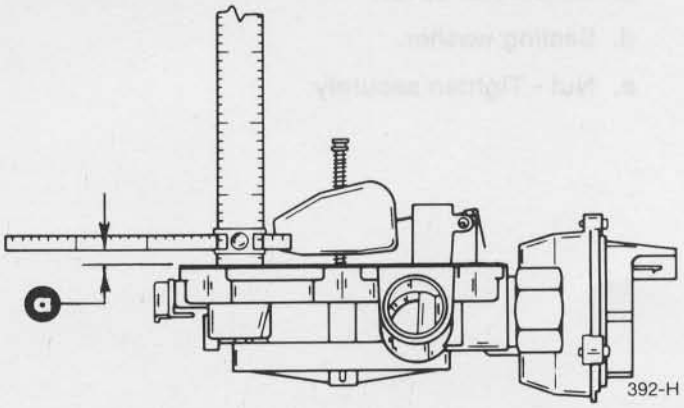
NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

Float Level

1. Turn air horn upside down. Pivot float assembly up-and-down on hinge pin to ensure it moves freely.

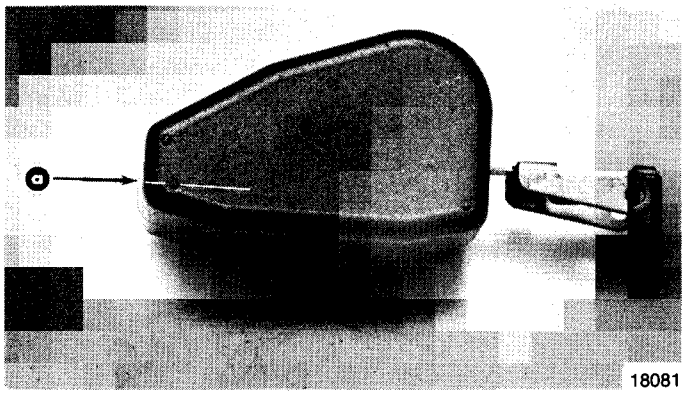
IMPORTANT: Before checking float level, raise float and allow it to fall; however, DO NOT force downward by hand.

2. Using Universal Carburetor Gauge, measure from gasket to toe of float.



a - See Specifications

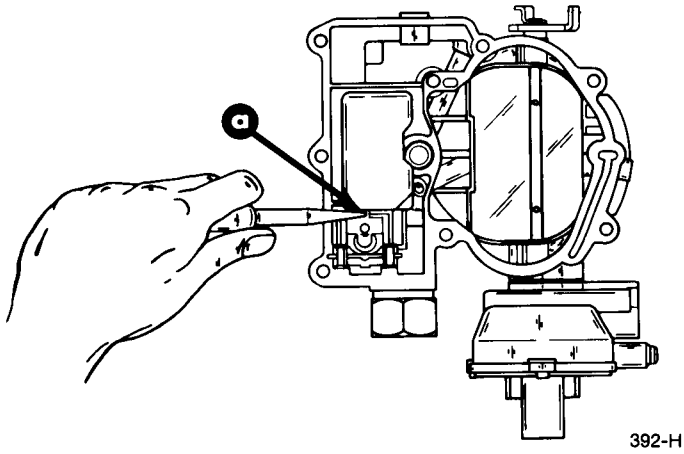
Measuring Float Level



a - Measure from This Point to Gasket

Toe of Float

3. Bend float arm up or down at point shown to obtain specified dimension.
4. Visually check float alignment after adjustment.

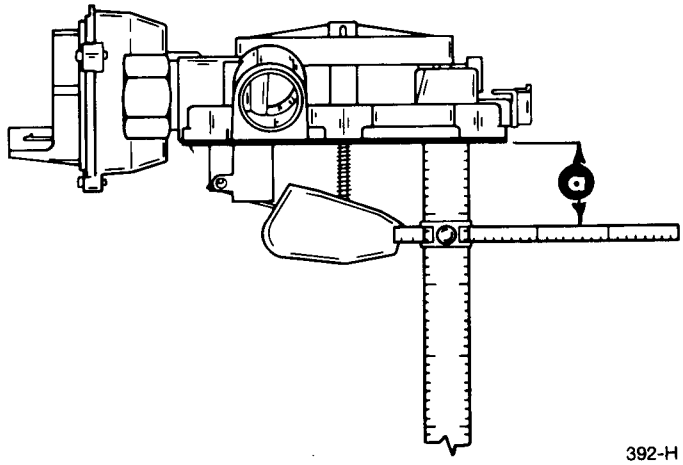


a - Bend Float Arm at this Point

Adjusting Float Level

Float Drop

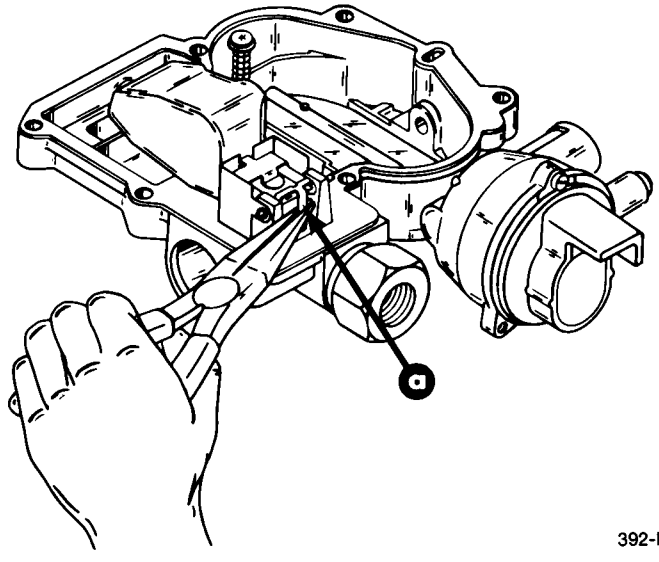
1. Hold air horn right-side-up to allow float to hang free.
2. Using Universal Carburetor Gauge, measure from gasket to toe of float.



a - See Specifications

Measuring Float Drop

3. Bend float assembly tang, as shown to obtain specified dimension.
4. Recheck BOTH float level and float drop.

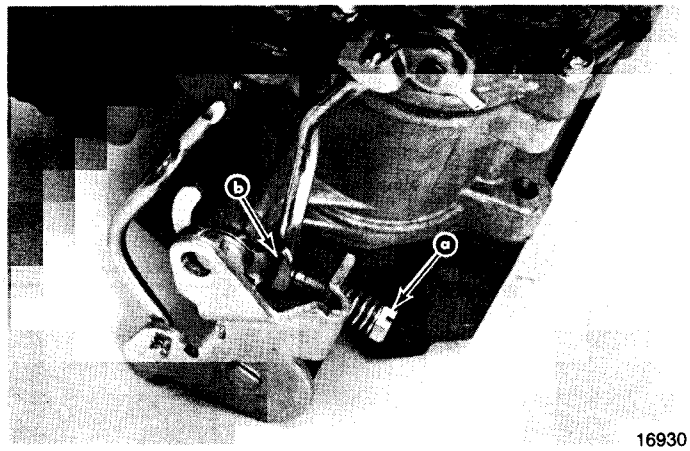


a - Float Assembly Tang

Adjusting Float Drop

Pump Rod

1. Back out idle speed screw until it no longer contacts idle cam.

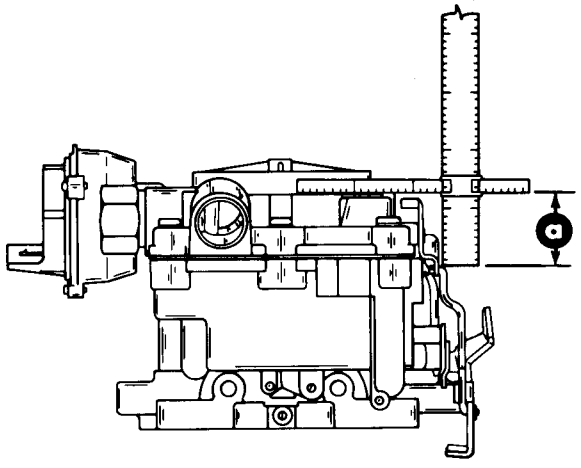


16930

a - Idle Speed Screw
b - Idle Cam

Backing Out Idle Speed Screw

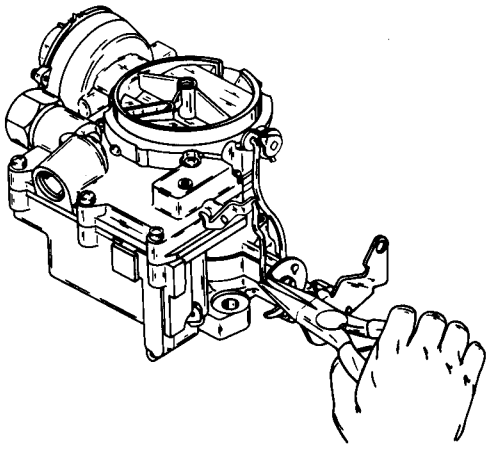
2. With throttle valves completely closed, measure from flame arrestor mounting surface to top of pump rod.
3. Carefully bend pump rod (where shown) to obtain specified dimension.



392-H

a - See Specifications

Measuring Pump Rod

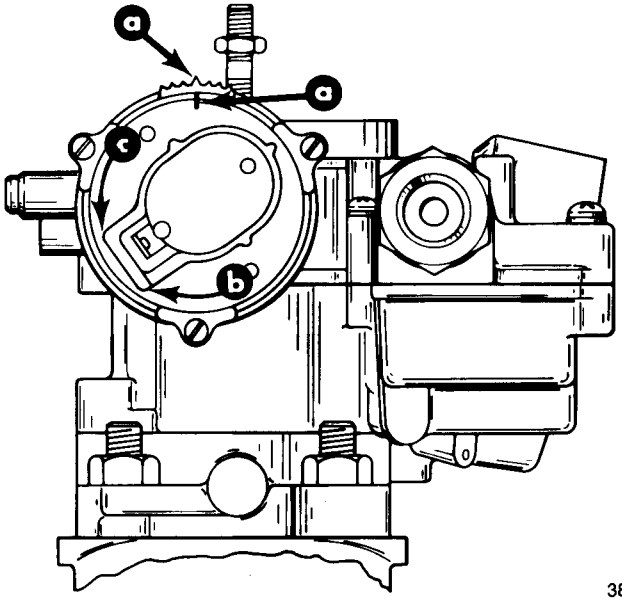


392-H

Adjusting Pump Rod

Choke Setting

Normal choke setting is such that scribed mark on cover is in line with long case mark on choke housing.



384-H

a - Marks on Choke Cover and Choke Housing
b - Leaner
c - Richer

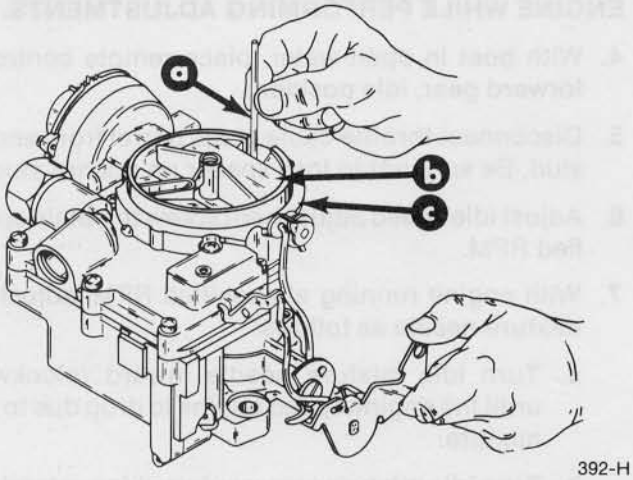
Choke Setting

If choke adjustment is necessary:

1. Loosen 3 choke cover retaining screws and adjust as shown.
2. Tighten 3 choke cover retaining screws securely.

Choke Unloader

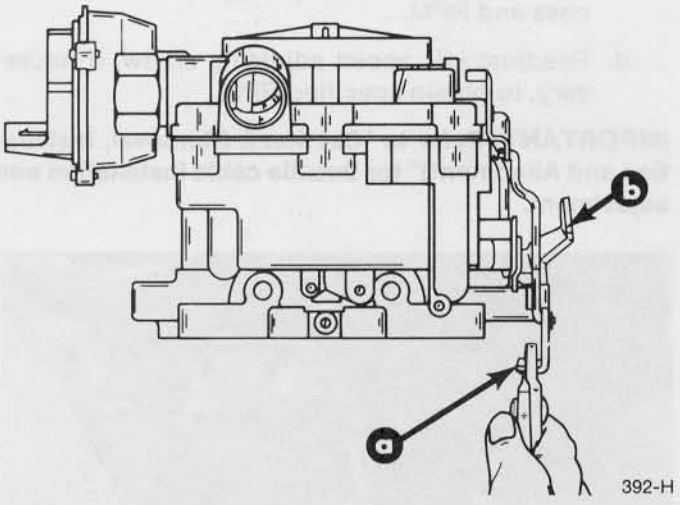
1. Hold throttle valves completely open.
2. Gently press down on choke plate.
3. Using an .080 in. (2.0mm) drill rod, or appropriate gauge, slide rod between upper edge of choke plate and air horn assembly. Rod should just slide through. If adjustment is required, proceed to Step 4.
4. Bend tang on throttle lever, if necessary, to obtain specified dimension.



392-H

a - .080 In. (2.0mm) Drill Rod
b - Choke Plate
c - Air Horn

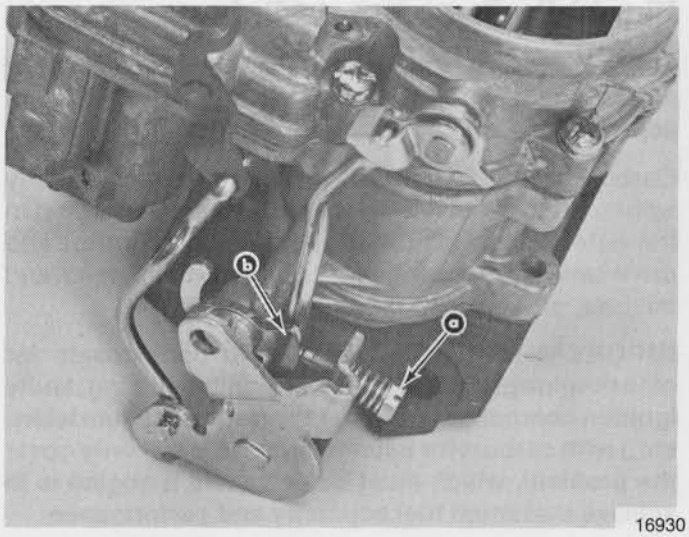
Checking Choke Unloader



392-H

a - Tang
b - Throttle Lever

Adjusting Choke Unloader



16930

a - Idle Speed Screw
b - Idle Cam

Preliminary Adjustment of Idle Speed Screw

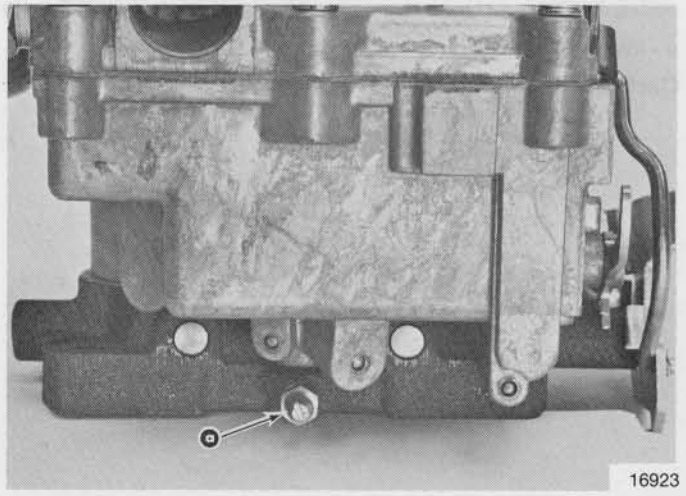
Preliminary Idle Speed and Mixture

IMPORTANT: The following adjustments will provide a sufficient idle speed and mixture for starting engine. Final adjustments must be made with engine running.

1. Turn idle speed screw in until it just contacts idle cam: then, turn screw in an additional two turns.

IMPORTANT: DO NOT turn idle mixture needle tightly against seat (in the following step), as damage to seat and/or needle may result.

2. Turn idle mixture needle in until they lightly seat; then, back needle out 1-1/4 turns.



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a - Idle Mixture Needle

Preliminary Idle Mixture Adjustment

Final Idle Speed and Mixture

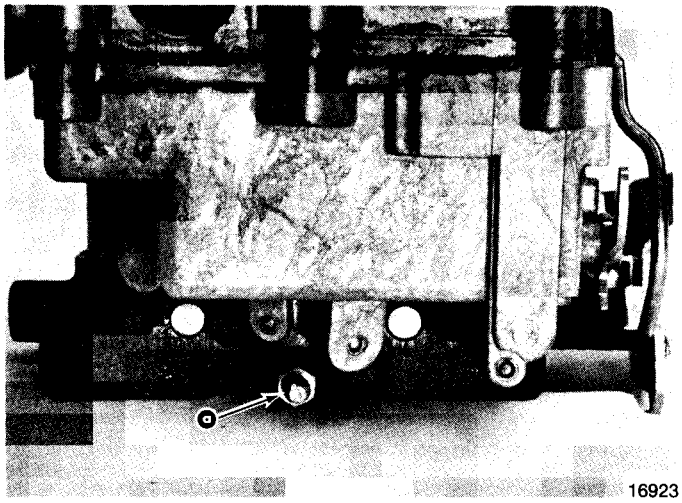
IMPORTANT: Boat must be in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles smoothly within range given under "Specifications", with boat in the water, engine at normal operating temperature and drive unit in forward gear. To adjust idle speed and mixture, proceed as follows:

IMPORTANT: DO NOT attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

1. Connect an accurate shop tachometer to engine.

IMPORTANT: DO NOT turn idle mixture needle tightly into seat, as damage to needle and/or seat may result.



a - Idle Mixture Needle

Carburetor Idle Mixture Needle

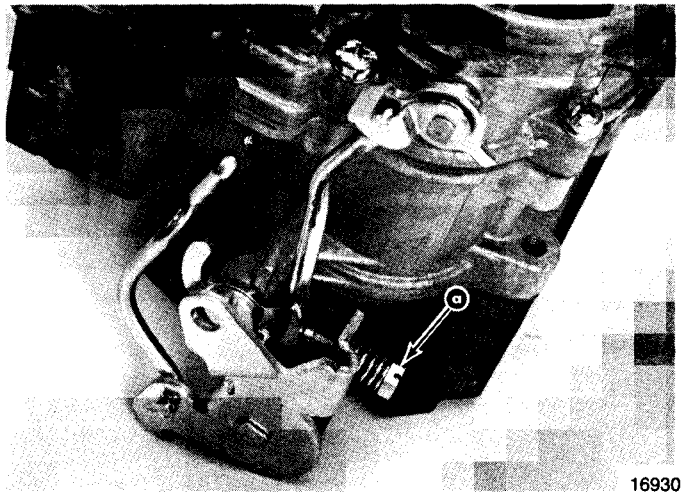
2. If a new or rebuilt carburetor has been installed, turn idle mixture needle in (clockwise) until it lightly contacts seat; then, back out needle 1-1/4 turns. This will provide a sufficient setting to allow starting engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠WARNING

DO NOT leave the helm unoccupied while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable brass barrel from anchor stud. Be sure not to lose spacer on anchor stud.
6. Adjust idle speed adjustment screw to obtain specified RPM.
7. With engine running at specified RPM, adjust idle mixture needle as follows:
   a. Turn idle mixture needle inward (clockwise) until the engine speed begins to drop due to lean mixture.
   b. Turn idle mixture screw outward (counterclockwise) until the speed begins to drop due to rich mixture.
   c. Turn screw inward to a point between these two extremes to obtain maximum engine smoothness and RPM.
   d. Readjust idle speed adjusting screw, if necessary, to obtain specified RPM.

IMPORTANT: Refer to "Section 2 (Removal, Installation and Alignment)" for throttle cable installation and adjustment.



a - Idle Speed Adjustment Screw

Idle Speed Adjusting Screw

Repair

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

Removal

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may, then, be inspected for contamination as carburetor is disassembled.

1. Remove ventilation hose from flame arrestor; then, remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

2. Turn fuel supply off at fuel tank.
3. Disconnect throttle cable from carburetor.
4. Remove swivel link assembly from carburetor.
5. Remove fuel line from fuel inlet nut.
6. Remove fuel pump sight tube from carburetor.
7. Disconnect electric choke.
8. Remove carburetor attaching nuts and washers and remove carburetor.
9. Remove and discard gaskets.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

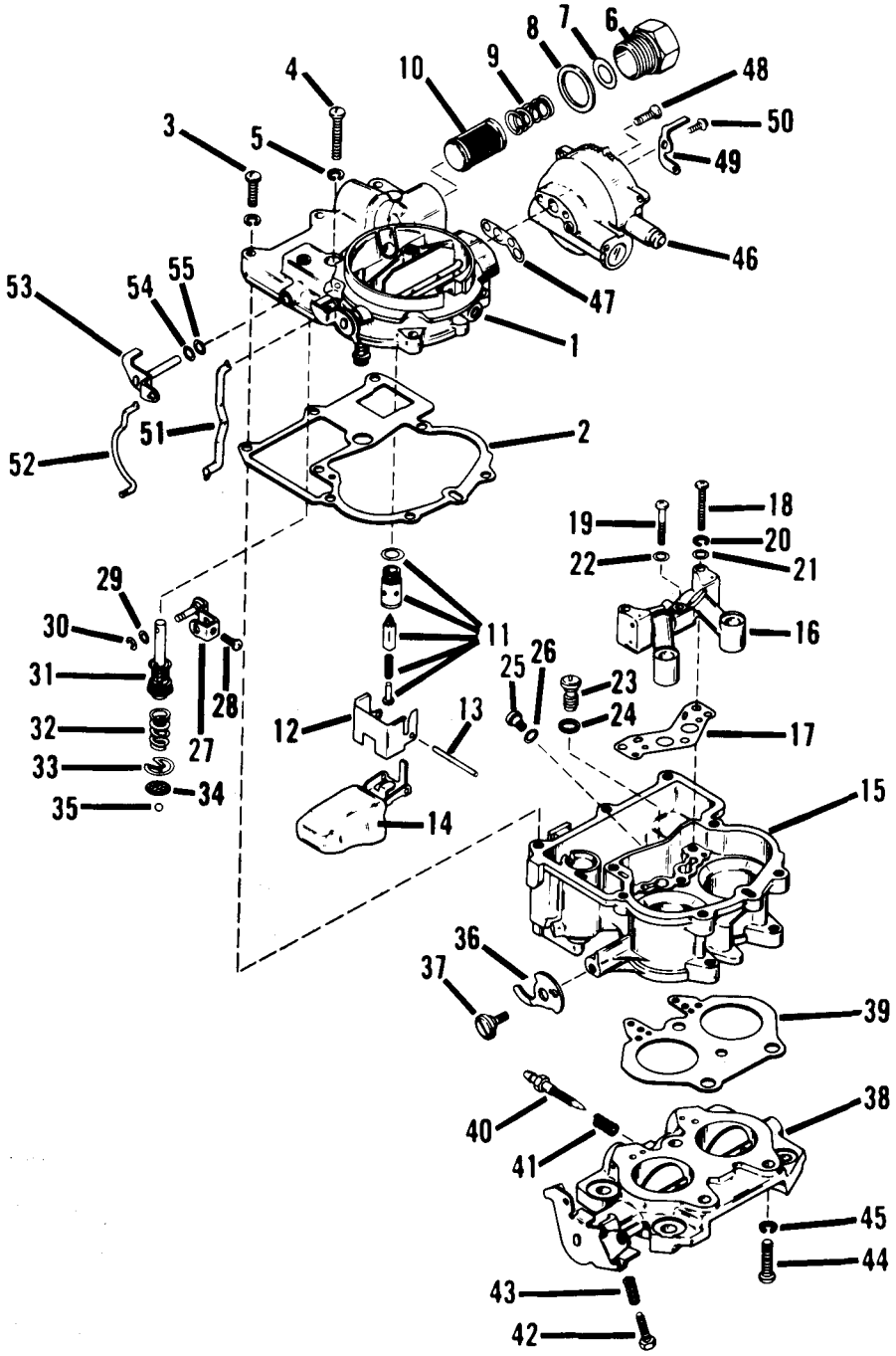
Installation

1. Thoroughly clean gasket surfaces.
2. Place new carburetor base gasket on intake manifold. Install carburetor and secure with nuts and washers. Torque to specifications.
3. Connect fuel line to fuel inlet nut and torque to specifications.
4. Conncet fuel pump sight tube to fitting on carburetor.
5. Connect electric choke wires to choke cover.
6. Check to ensure that 8-12 threads of link rod are exposed from swivel; then, attach swivel link assembly to throttle lever, using nut and washer.
7. Move intermediate throttle lever back-and-forth and check for binding in throttle linkage. If binding occurs, remove swivel link assembly from throttle lever and adjust link (by turning link rod), as required, to eliminate binding.
8. Install throttle cable, as explained, in "Section 2".
9. Install flame arrestor and crankcase ventilation hose.
10. Reconnect battery cables to battery.
11. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
12. Adjust idle speed and idle mixture, as outlined under "Adjustments" preceding.

Dissassembly

The following is a step-by-step procedure for completely over-hauling carburetor removed from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing any unnecessary steps.

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.



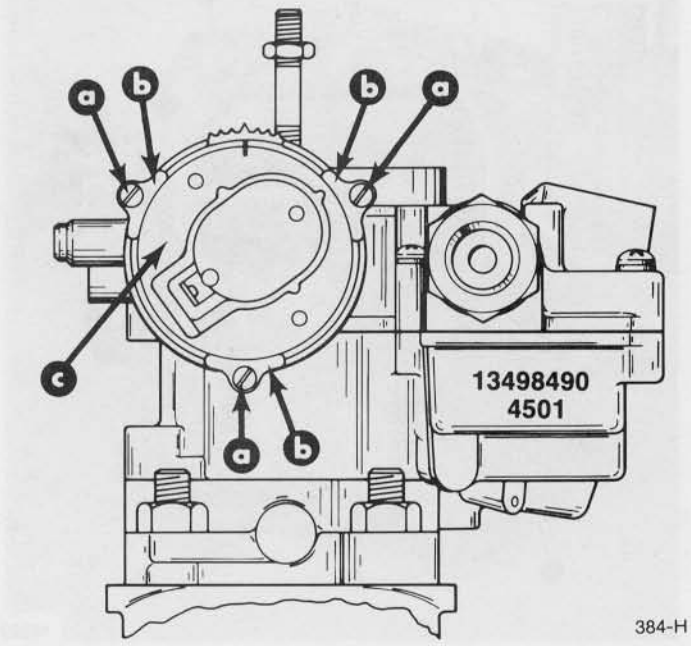
392-H

MerCarb Two-Barrel

1 - Air Horn
2 - Gasket
3 - Screw
4 - Screw
5 - Lockwasher
6 - Nut - Fuel Inlet
7 - Gasket
8 - Gasket
9 - Spring
10 - Filter
11 - Inlet Needle and Seat
12 - Baffle Plate
13 - Pin
14 - Float
15 - Float Bowl
16 - Venturi Cluster
17 - Gasket
18 - Screw
19 - Screw
20 - Lockwasher
21 - Gasket
22 - Gasket
23 - Power Valve Assembly
24 - Gasket
25 - Jet
26 - Gasket
27 - Pump Shaft and Lever Assembly
28 - Screw
29 - Washer
30 - Clip - Retainer
31 - Accelerator Pump Assembly
32 - Spring
33 - Clip - Retainer
34 - Strainer
35 - Check Ball
36 - Cam - Idle
37 - Screw
38 - Throttle Body
39 - Gasket
40 - Idle Mixture Adjusting Needle
41 - Spring
42 - Screw - Idle Speed Adjusting
43 - Spring
44 - Screw
45 - Lockwasher
46 - Choke/Housing
47 - Gasket
48 - Screw
49 - Lever Assembly
50 - Screw
51 - Rod - Choke
52 - Rod - Accelerator Pump
53 - Accelerator Pump Shaft and Lever Assembly
54 - Washer - (Outer)
55 - Washer - (Inner)

CHOKE HOUSING ASSEMBLY

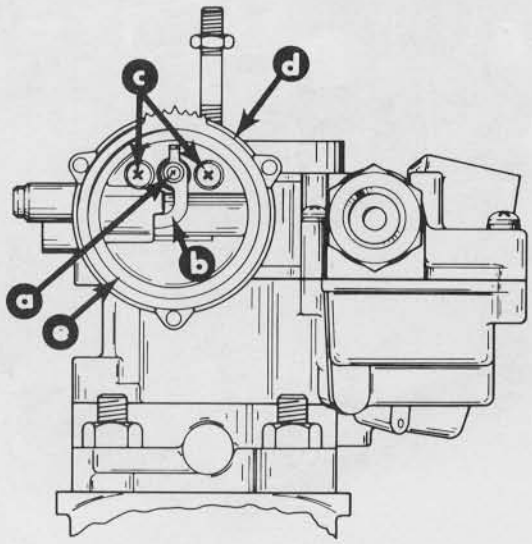
1. Remove choke cover as shown.



a - Screws
b - Retainers — Remove
c - Choke Cover

Removing Choke Cover

2. Remove choke lever as shown.
3. Remove choke housing assembly as shown.

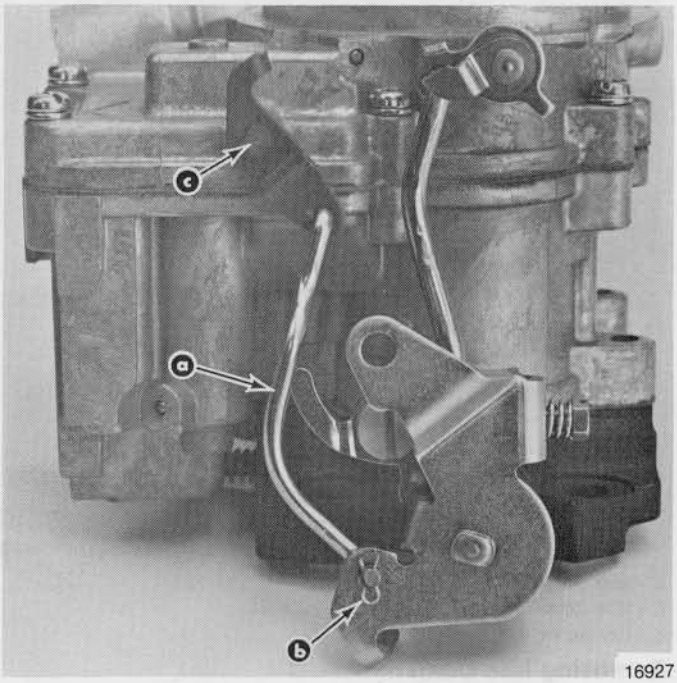


a - Screw - Choke Lever
b - Choke Lever
c - Screws - Choke Housing Assembly — Remove
d - Gasket (If Equipped)
e - Choke Housing Assembly

Removing Choke Lever and Choke Housing Assembly

AIR HORN

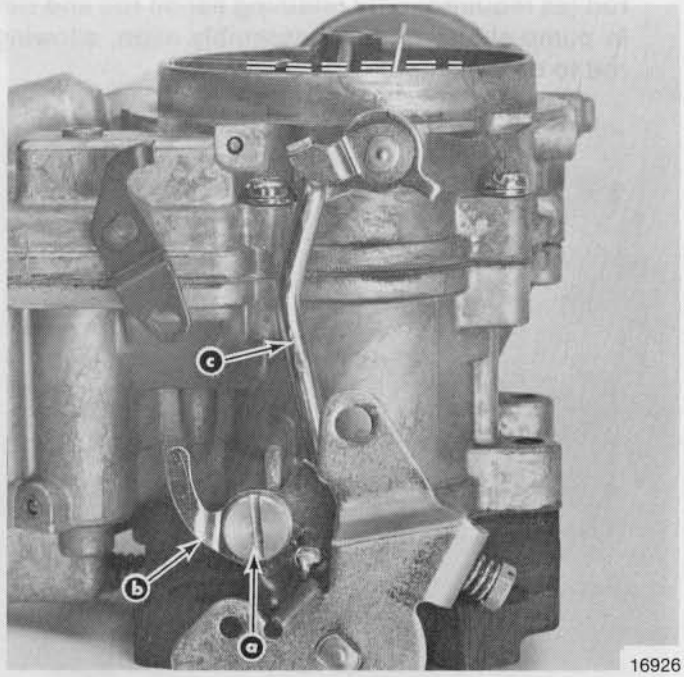
1. Remove fuel inlet filter nut, washers, spring, and filter, as outlined.
2. Remove accelerator pump rod retaining clip. Pivot rod (as required) until retaining ear on rod and slot in pump shaft and lever assembly align, allowing rod to be pulled out.



a - Accelerator Pump Rod
b - Retainer Clip
c - Pump Shaft and Lever Assembly

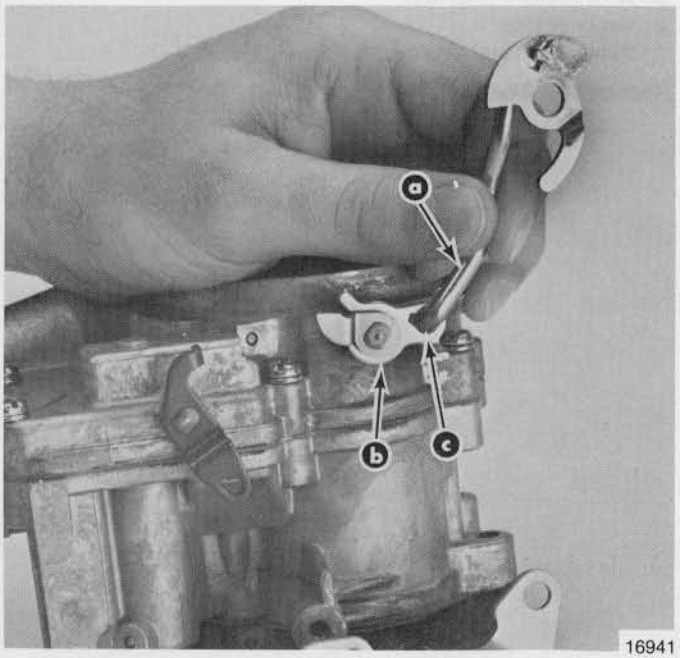
Removing Accelerator Pump Rod

3. Remove idle cam screw. Also, remove choke rod by pivoting rod (as required) until retaining ear on rod and slot in choke lever align, allowing rod to be pulled out.



a - Idle Cam Screw
b - Idle Cam
c - Choke Rod

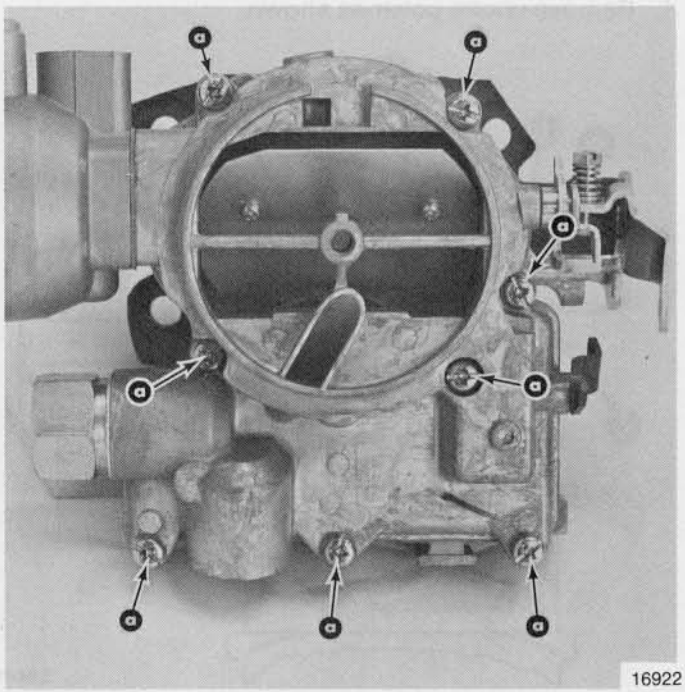
Removing Idle Cam



a - Choke Rod
b - Choke Lever
c - Slot

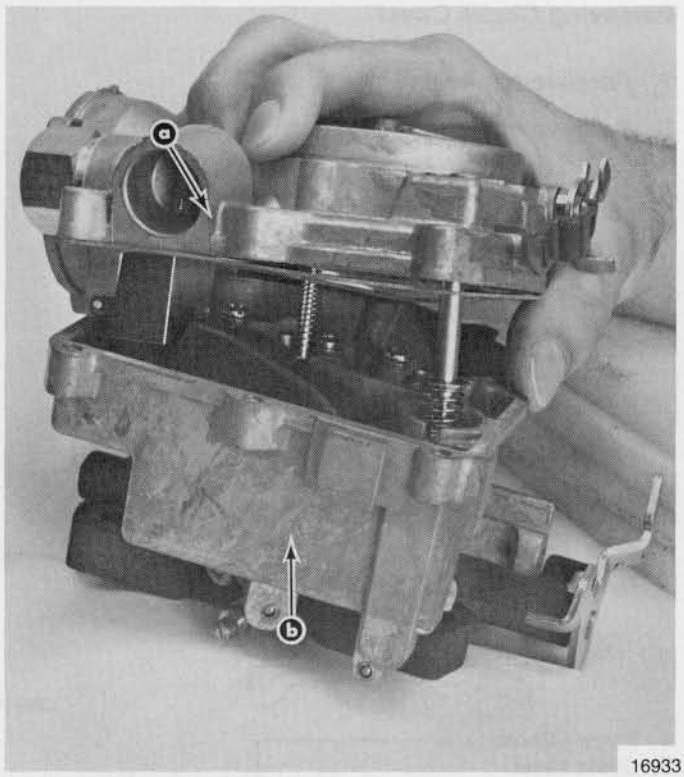
Removing Choke Rod

4. Remove air horn as shown.



a - Air Horn Attaching Screws

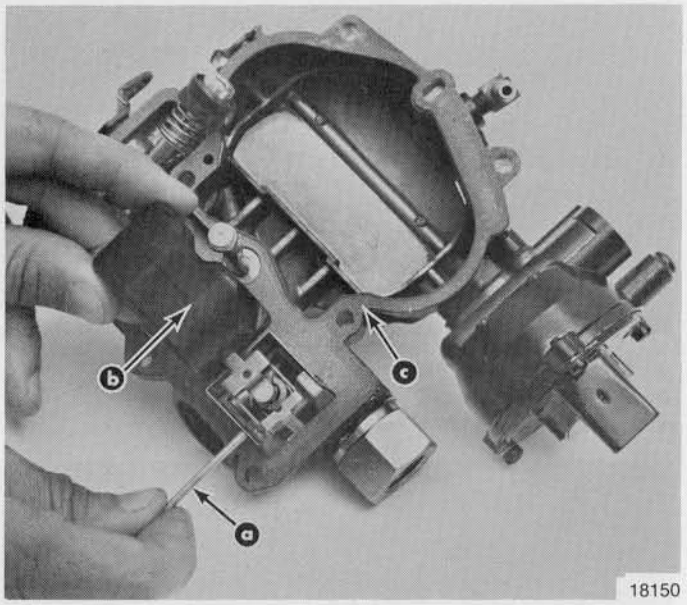
Air Horn Attaching Screw Location



a - Air Horn - Carefully Lift Off
b - Float Bowl Assembly

Carefully Removing Air Horn

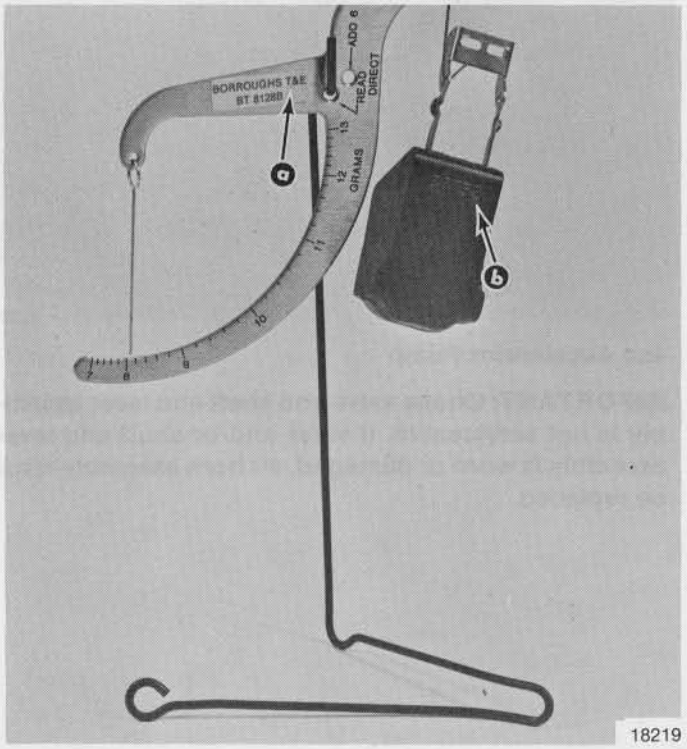
5. Invert air horn and carefully lay on bench.
6. Remove float hinge pin and lift float assembly from air horn. Check float weight as shown.
7. Remove air horn gasket.



18150

a - Float Hinge Pin
b - Float Assembly
c - Air Horn Gasket

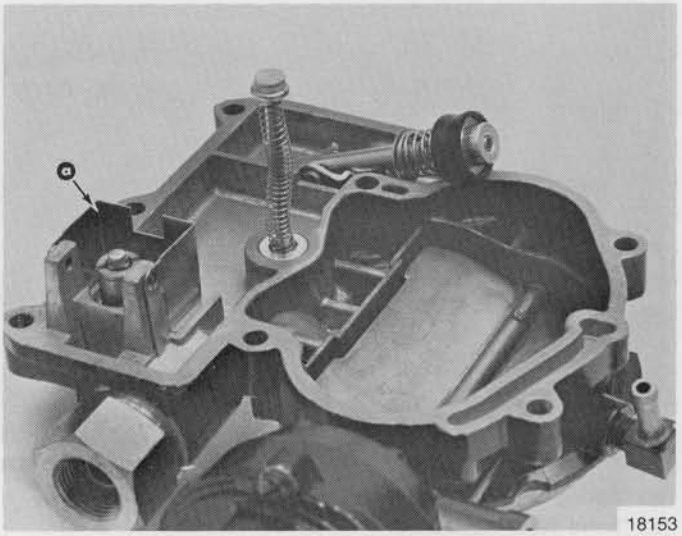
Removing Float Assembly and Air Horn Gasket



18219

a - Grams Scale
b - Float

Checking Float Weight

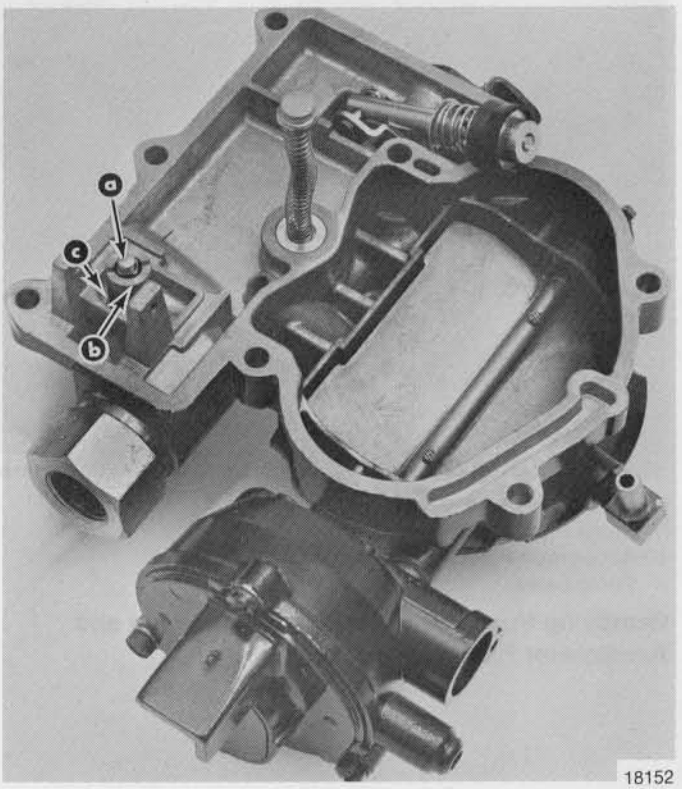


18153

a - Baffle

Removing Baffle

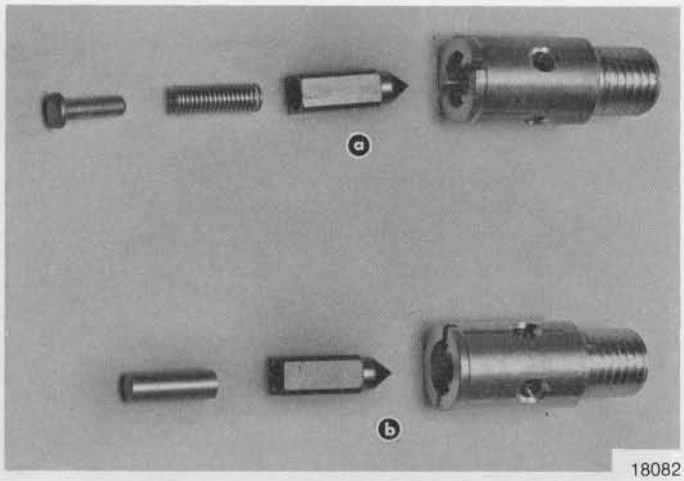
8. Remove baffle.
9. Remove needle assembly.
10. Remove needle seat and gasket.



18152

a - Needle Assembly
b - Needle Seat
c - Gasket

Removing Needle Assembly, Needle Seat and Gasket

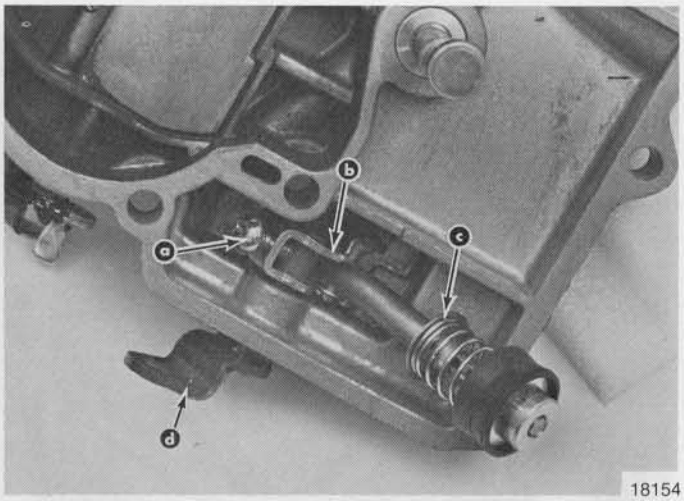


18082

a - "Spring Loaded Type" Needle
b - "Solid Type" Needle -

Types of Needle and Seat Assemblies

11. Loosen accelerator pump screw. Slide pump shaft and lever assembly (and washer) out of air horn; then, remove accelerator pump assembly and pump lever.

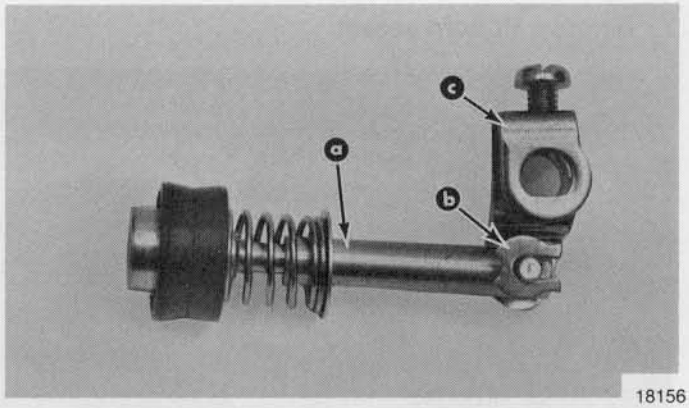


18154

a - Accelerator Pump Screw
b - Pump Shaft and Lever Assembly
c - Accelerator Pump (2cc Pump Shown)
d - Pump Lever

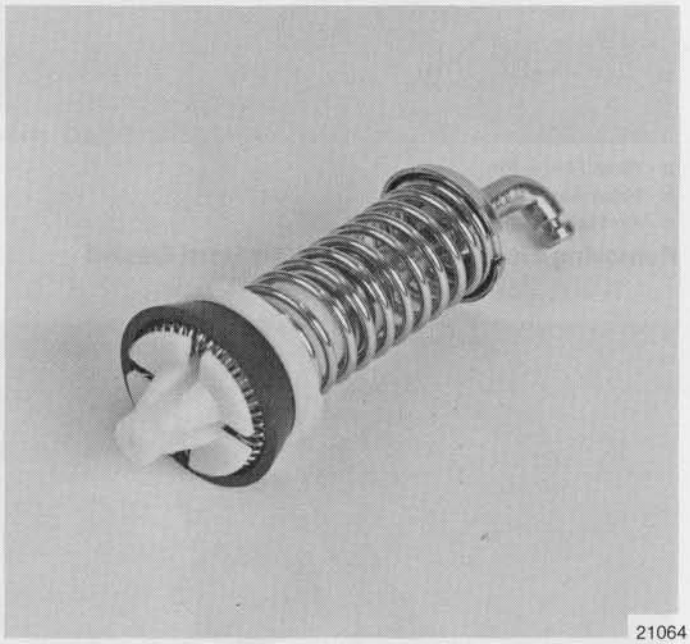
Removing Pump Shaft and Lever Assembly and Accelerator Pump Assembly

12. Remove retainer clip and washer from pump shaft and lever assembly; then, remove accelerator pump assembly.



18156

a - Accelerator Pump Assembly (2cc Pump Shown)
b - Retainer Clip
c - Pump Shaft and Lever Assembly

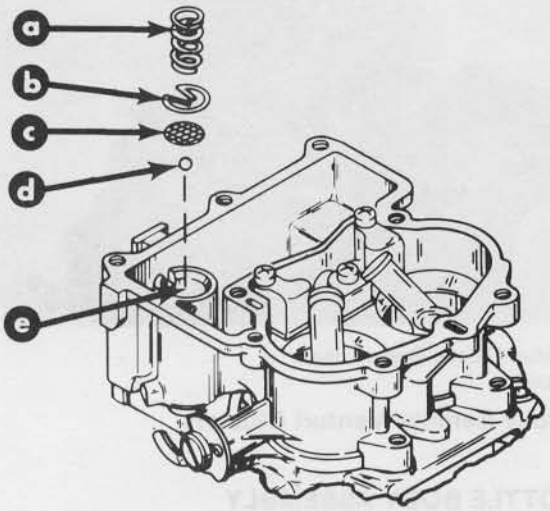

21064

4cc Accelerator Pump

IMPORTANT: Choke valve and shaft and lever assembly is not serviceable. If valve and/or shaft and lever assembly is worn or damaged, air horn assembly must be replaced.

FLOAT BOWL ASSEMBLY

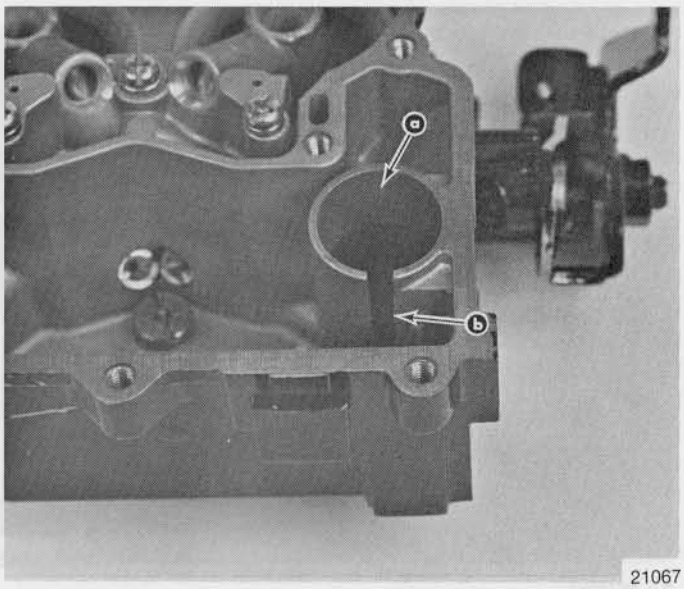
1. Remove accelerator pump return spring from pump well.
2. Carefully remove retainer clip, strainer, and check ball from pump well.



392-H

a - Accelerator Pump Return Spring
b - Retainer Clip
c - Strainer
d - Check Ball
e - Pump Well

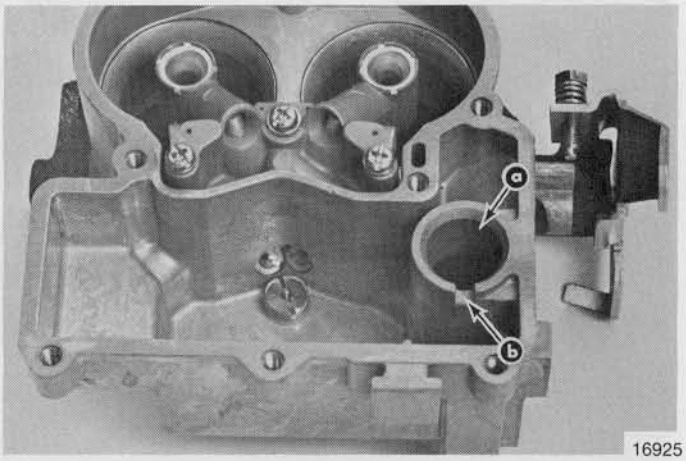
Removing Accelerator Pump Return Spring, Retainer Clip, Strainer, and Check Ball (2cc Pump Only)



21067

a - Large Pump Bore
b - Long Groove

Float Bowl Assembly for 4cc Accelerator Pump

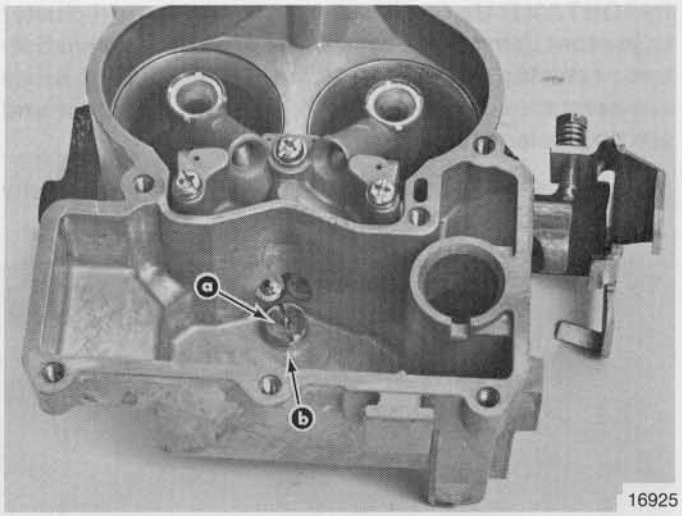


16925

a - Small Pump bore
b - Short Groove

Float Bowl Assembly for 2cc Accelerator Pump

3. Remove power valve assembly and gasket.

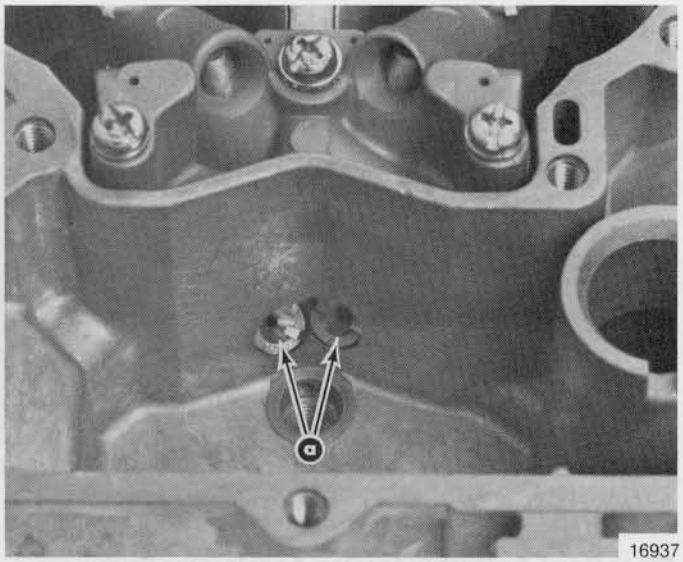


16925

a - Power Valve Assembly
b - Gasket

Removing Power Valve Assembly

4. Remove main metering jets and gaskets.

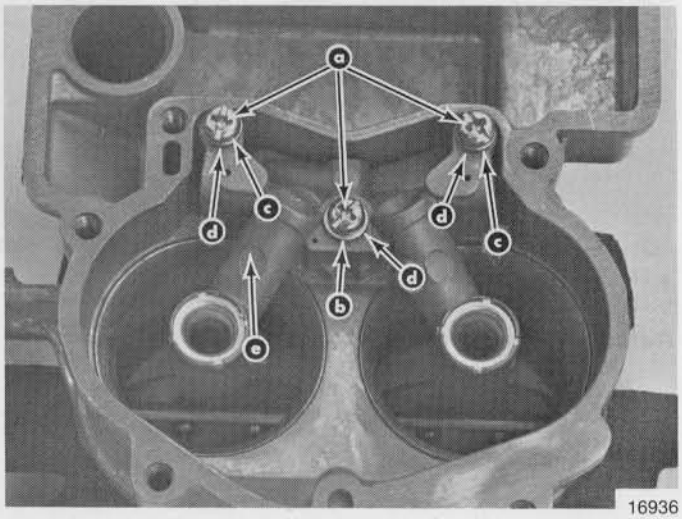


a - Main Metering Jets - Gaskets Not Seen in Photo

Removing Main Metering Jets

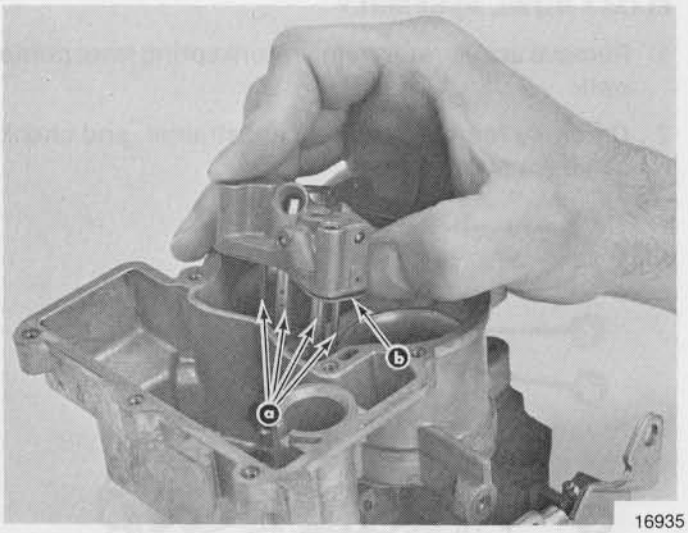
IMPORTANT: Use care when removing venturi cluster to prevent damaging brass tubes protruding from bottom of cluster. DO NOT REMOVE TUBES. These tubes are permanently pressed into the venturi cluster and are not replaceable.

5. Remove three venturi cluster screws, and carefully remove cluster and venturi gasket.



a - Screws/Lockwashers

Removing Venturi Cluster Attaching Screws



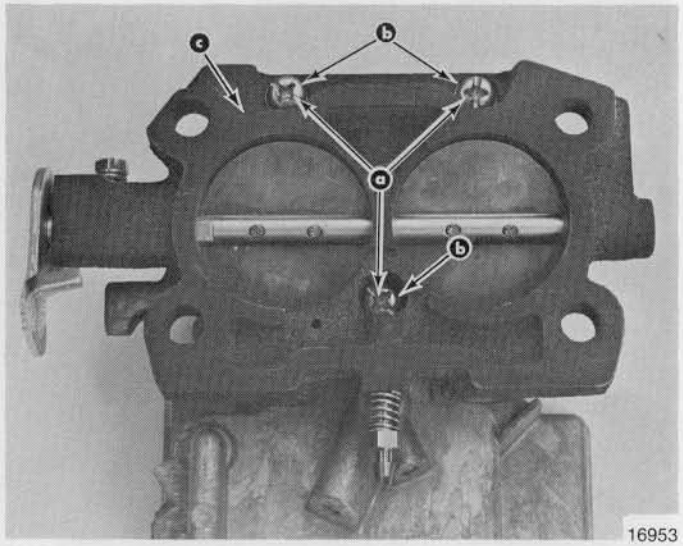
a - Venturi Cluster Brass Tubes
b - Gasket

Carefully Remove Venturi Clusters

THROTTLE BODY ASSEMBLY

IMPORTANT: Use extreme care when handling throttle body, so as not to damage throttle valves.

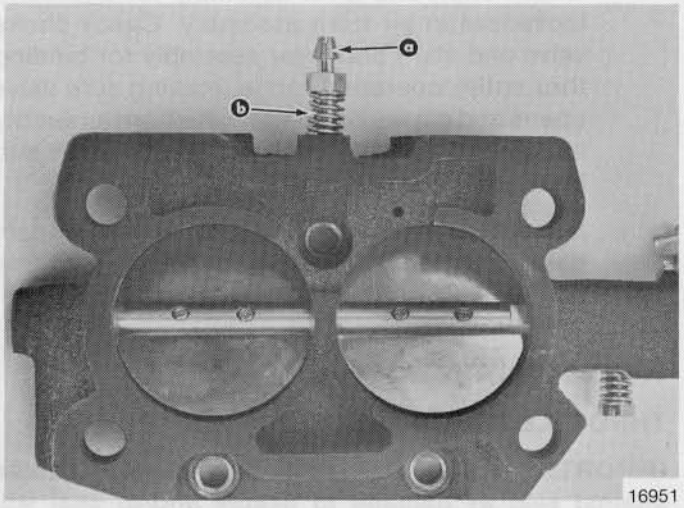
1. Place float bowl assembly upside down. Remove three throttle body assembly attaching screws and lockwashers, and remove throttle body and gasket from float bowl.



a - Screws
b - Lockwashers
c - Throttle Body - Gasket Not Seen in Photo

Separating Throttle Body from Float Bowl Assembly

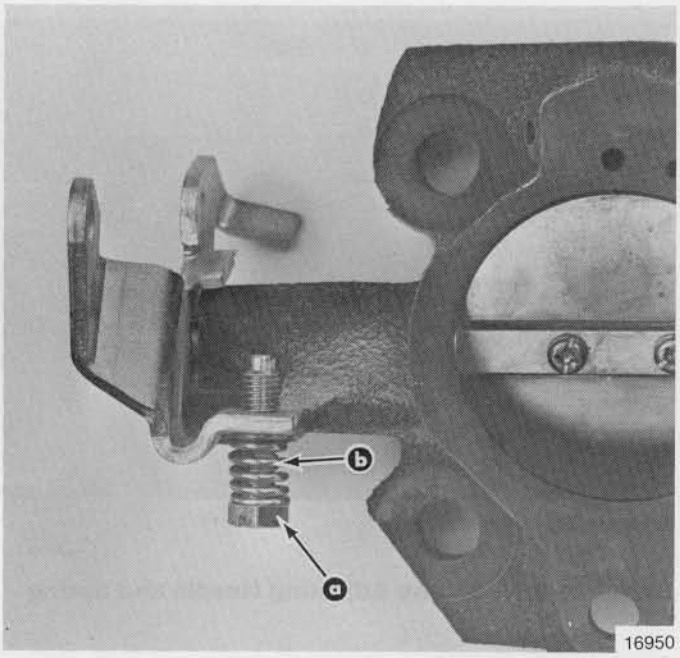
2. Remove idle mixture adjusting needle and spring.



a - Idle Mixture Adjusting Needle
b - Spring

Removing Idle Adjusting Needle and Spring

3. Remove idle speed screw and spring, if replacement is necessary.



a - Idle Speed Screw
b - Spring

Removing Idle Speed Screw and Spring

IMPORTANT: DO NOT remove throttle valves. If any of the throttle body parts are found to be worn or damaged, complete throttle body assembly MUST BE replaced. Throttle body assembly can be cleaned in carburetor cleaner.

Cleaning and Inspection

IMPORTANT: DO NOT use a wire or drill to clean jets, passages, or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

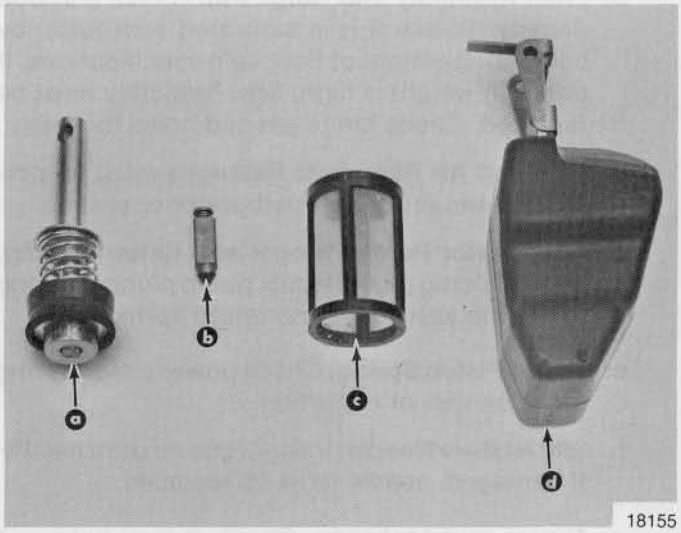
⚠CAUTION

Do not leave carburetor in carb cleaner for more than two hours.

IMPORTANT: DO NOT clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and float bowl replacement will be necessary.

⚠CAUTION

The float assembly, float needle, accelerator pump plunger, and fuel filter MUST NOT BE immersed in carburetor cleaner, as they will swell, harden, and/or distort.



a - Accelerator Pump Plunger (2cc Pump Shown)
b - Float Needle
c - Fuel Filter
d - Float Assembly

Items Which MUST NOT BE Immersed in Carburetor Cleaner

1. Thoroughly clean all metal parts in a commercial carburetor cleaner, until all deposits have been removed. Follow manufacturer's instructions of cleaner being used for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe-off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage; pay particular attention to the following:

   a. **Float Needle and Seat:** If float needle or seat is worn or damaged, replace with a new needle and seat assembly.

IMPORTANT: Float needle and seat are factory matched and tested and should be replaced as a set only.

   b. **Float Assembly and Hinge Pin:** Check pontoon density (to see if it is saturated with fuel), by comparing weight of float with specifications. If pontoon weight is high, float assembly must be replaced. Check hinge pin and holes for wear.

   c. **Fuel and Air Passages:** Passages must be perfectly clean for proper carburetor operation.

   d. **Accelerator Pump Plunger and Return Spring:** Inspect pump plunger cup, pump plunger spring (on pump assembly) and return spring.

   e. **Power Piston Spring:** Check power piston spring for weakness or distortion.

   f. **Idle Mixture Needle:** Inspect idle mixture needle. If damaged, needle must be replaced.

   g. **Levers and Linkages:** Check levers, links and rods for wear.

   h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Check throttle valve and shaft for binding thru entire operating range, making sure valve opens and closes completely. Throttle body assembly must be replaced if throttle valve and shaft are worn or damaged.

   i. **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding thru entire operating range, making sure valve opens and closes completely. Air horn assembly must be replaced if choke valve and shaft and lever assembly are worn or damaged.

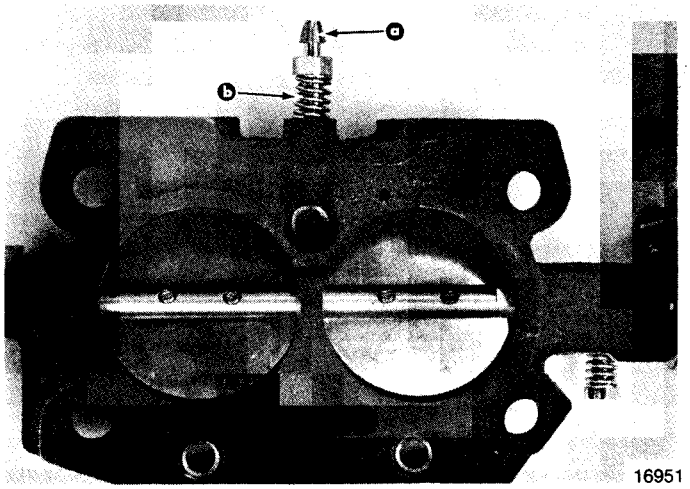
   j. **Inspect Casting** for visible damage. Inspect gasket surfaces. Inspect accelerator pump plunger well for scoring or deposits.

Reassembly

THROTTLE BODY ASSEMBLY

IMPORTANT: DO NOT force idle mixture needle against seat as damage to needle and/or seat will result.

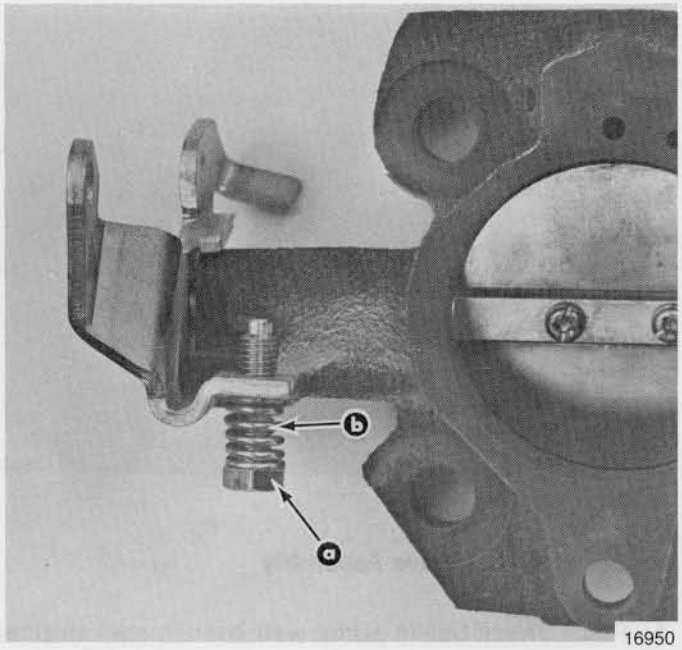
1. Screw idle mixture needle (and spring) into throttle body until they lightly seat; then, back out needle 1-1/4 turns as a preliminary idle mixture setting. Final adjustment will be made with engine running. Refer to "Adjustments".



a - Idle Mixture Needle
b - Spring

Installing Idle Mixture Adjusting Needle and Spring

2. Thread idle speed screw and spring into throttle lever.



16950

a - Idle Speed Screw
b - Spring

Installing Idle Speed Screw

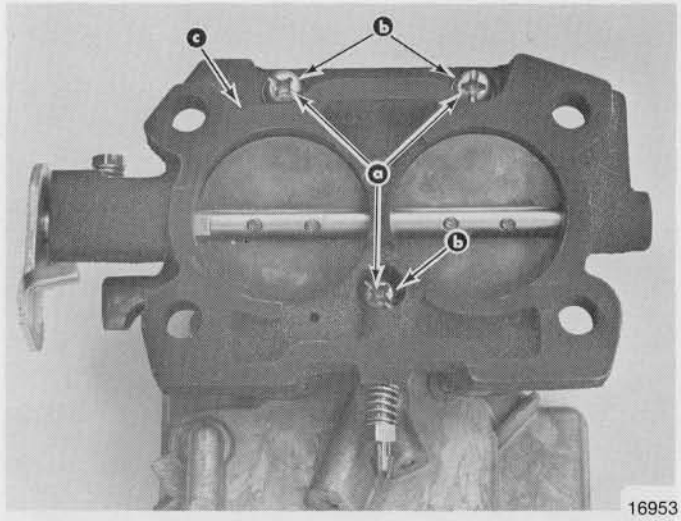
3. Turn float bowl assembly upside-down and place new throttle body gasket on bowl, making sure gasket is properly positioned on locating dowel.

16949

a - Throttle Body Gasket
b - Locating Dowel

Throttle Body Gasket Properly Positioned on Float Bowl Assembly

4. Install throttle body assembly on float bowl assembly, making sure that screw holes in gasket line up with screw holes in throttle body. Tighten screws evenly and securely.



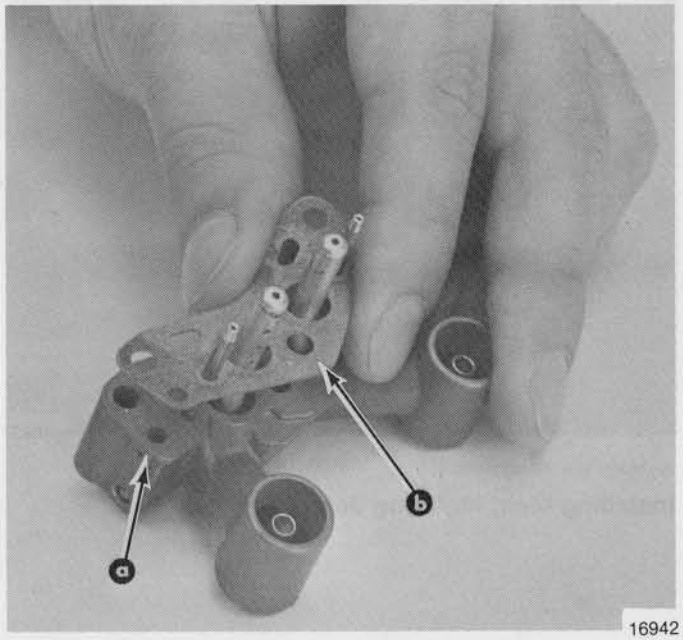
16953

a - Screws
b - Lockwashers
c - Throttle Body Assembly

Installing Throttle Body Assembly on Float Bowl Assembly

FLOAT BOWL ASSEMBLY

IMPORTANT: Place float bowl and throttle assemblies in holding fixture to prevent throttle valves from being damaged.

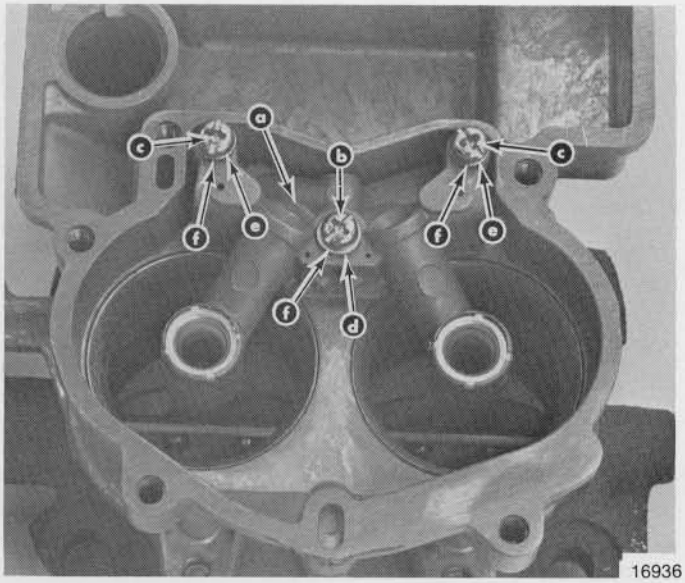


16942

a - Venturi Cluster
b - Gasket

Placing Gasket on Venturi Cluster

1. Place new gasket over venturi cluster brass tubes. Carefully, install venturi cluster in float bowl, using three screws, gaskets and lockwashers as shown. Tighten screws evenly and securely.

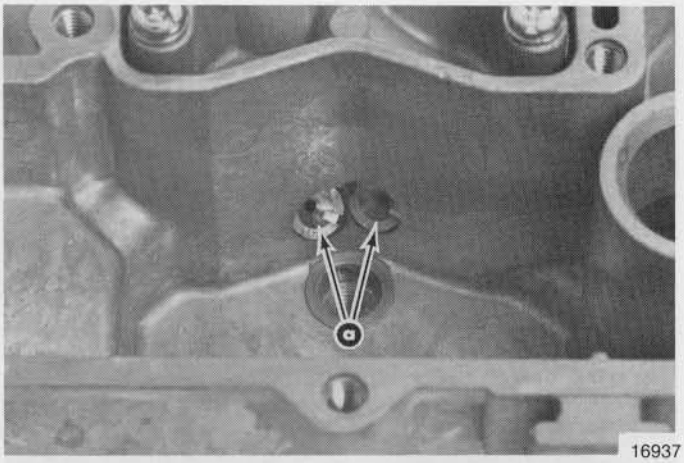


16936

a - Venturi Cluster
b - Center Screw (With Smooth Shank)
c - Outer Screws
d - Fiber Washer
e - Lockwashers
f - Metal Gaskets

Installing Venturi Cluster

2. Install main metering jets and gaskets in bottom of float bowl assembly; tighten jets securely.

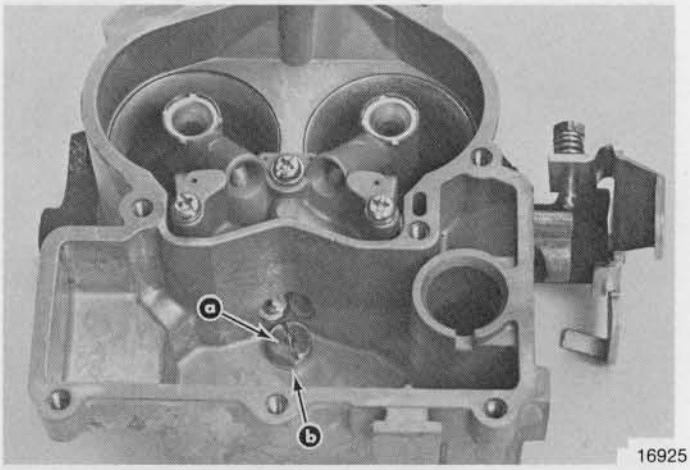


16937

a -Main Metering Jets

Installing Main Metering Jets

3. Install power valve assembly and gasket in bottom of float bowl assembly and tighten securely.

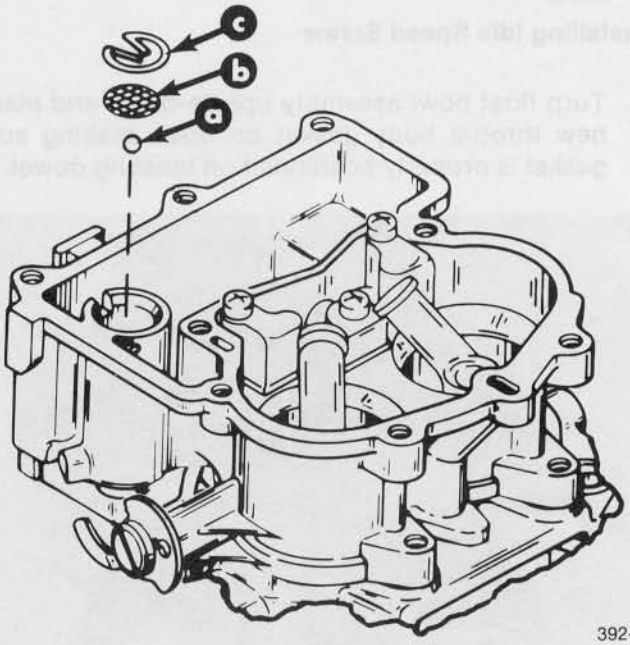


16925

a - Power Valve Assembly
b - Gasket

Installing Power Valve Assembly

4. Place check ball in pump well; then, install strainer and retainer clip.

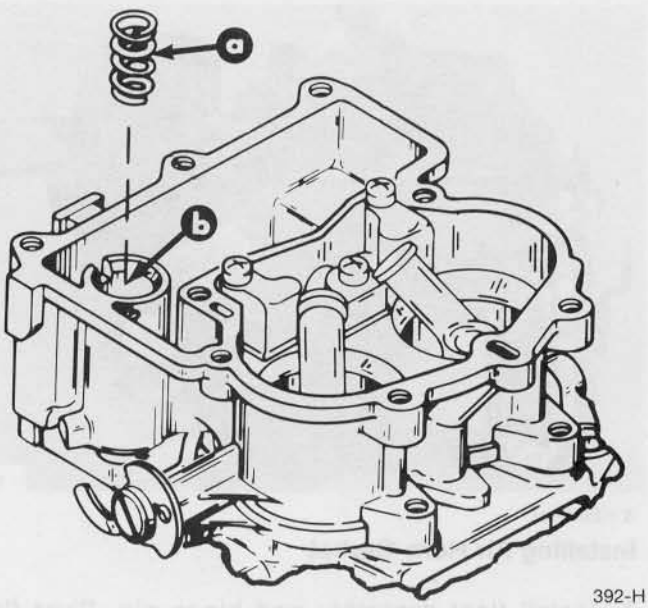


392-H

a - Check Ball
b - Strainer
c - Retainer Clip

Installing Check Ball, Strainer, and Retainer Clip (2cc Pump Only)

5. Place accelerator pump return spring in pump well.



392-H

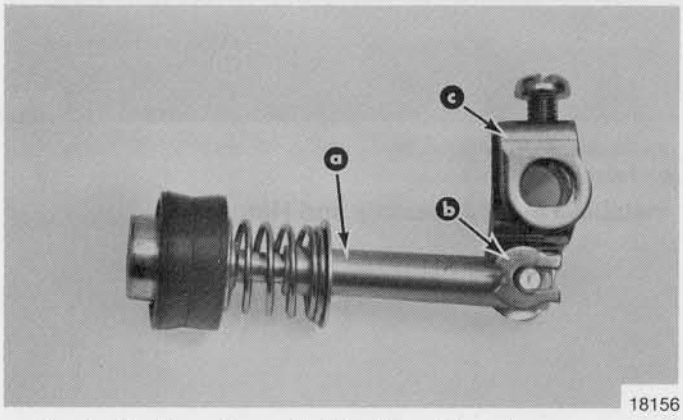
a - Accelerator Pump Return Spring
b - Pump Well

Installing Accelerator Pump (2cc Pump Only)

AIR HORN ASSEMBLY

IMPORTANT: Accelerator pump assembly MUST BE installed correctly. If pump assembly is installed incorrectly, top of pump assembly will contact air horn casting.

1. If accelerator pump assembly was removed from pump lever, secure pump assembly to pump lever with washer and retainer clip, as shown.

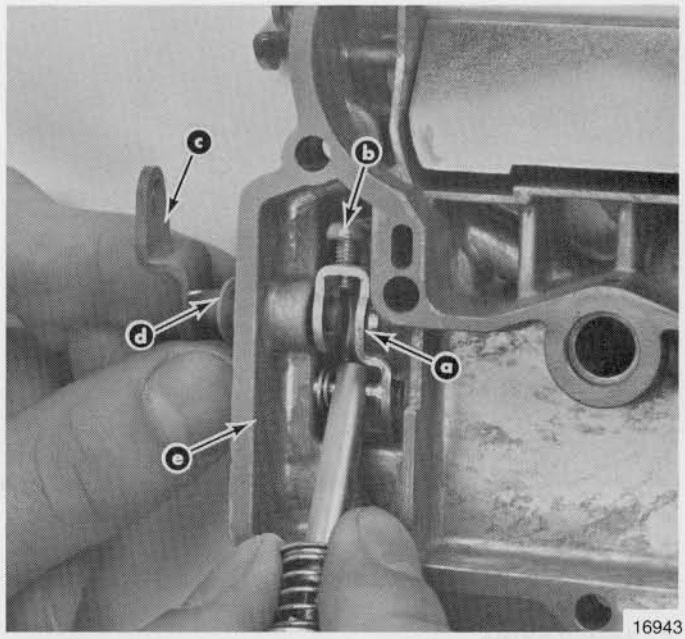


18156

a - Accelerator Pump Assembly (2cc Pump Shown)
b - Retainer Clip
c - Pump Lever

Securing Accelerator Pump Assembly to Pump Lever

2. Insert pump shaft and lever assembly (and washer) into air horn; then, align indexed hole in pump lever with shaft and lever assembly and slide shaft all-the-way into lever so that shoulder on shaft is hitting lever. Tighten set screw securely.

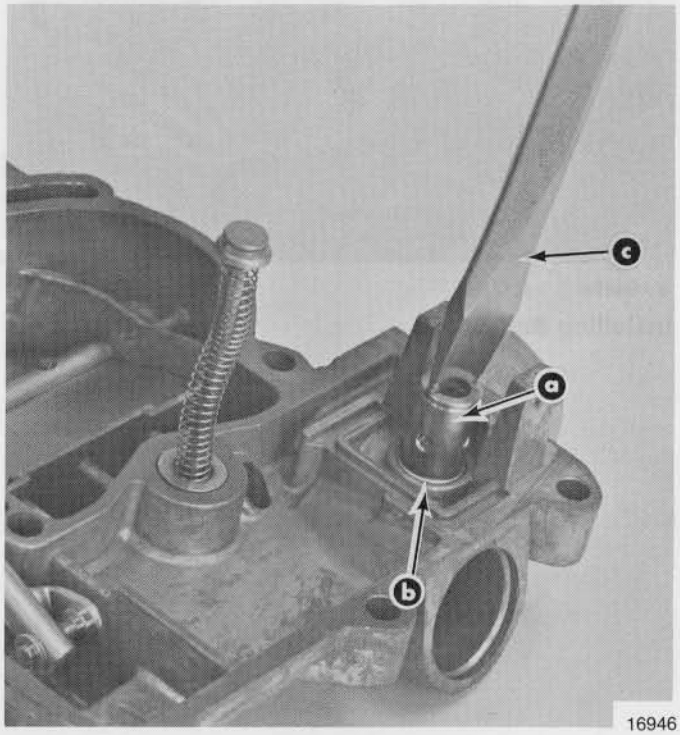


16943

a - Pump Lever
b - Set Screw
c - Pump Shaft and Lever Assembly
d - Washer
e - Air Horn

Installing Accelerator Pump Assembly and Pump Shaft and Lever Assembly

3. Install needle seat and gasket, using appropriate width screwdriver.



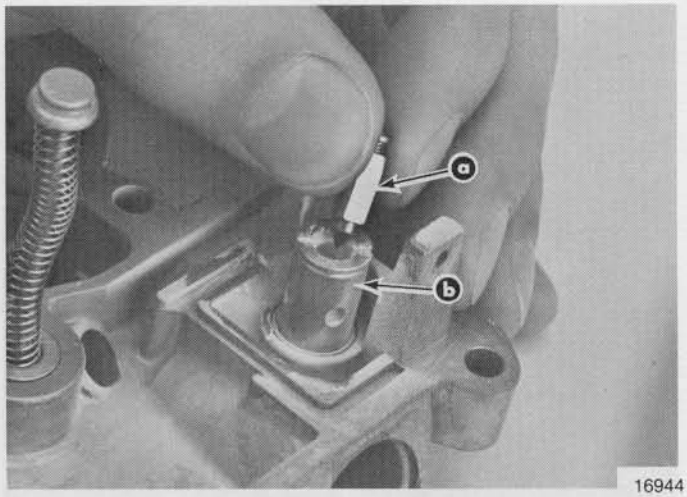
16946

a - Needle Seat b - Gasket c - Screwdriver

Installing Needle Seat and Gasket

IMPORTANT: Float needle and needle seat are factory matched and tested and should be replaced as a set only.

4. Place needle assembly in needle seat.

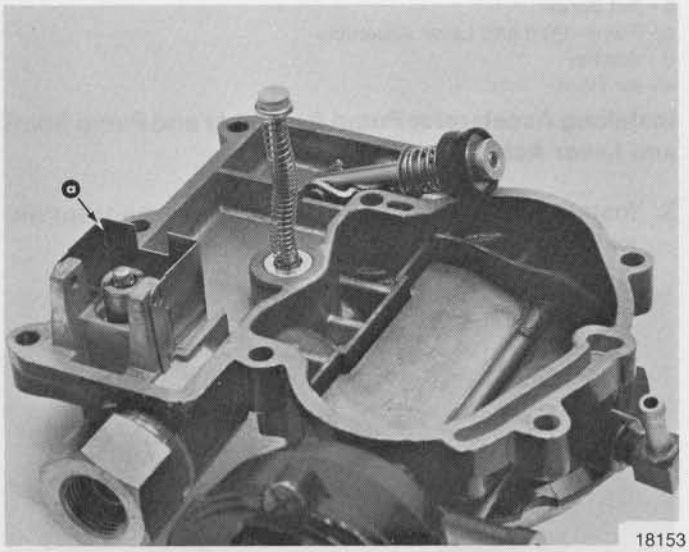


16944

a - Needle Assembly
b - Needle Seat

Installing Needle Assembly

5. Install baffle.

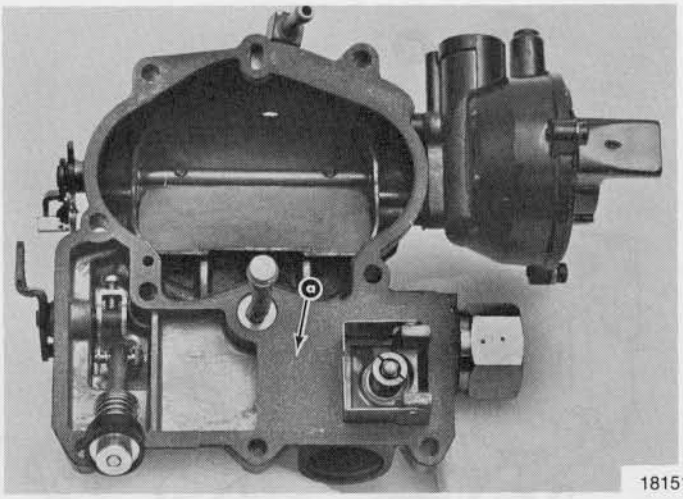


18153

a - Baffle

Installing Baffle

6. Place new gasket on air horn.

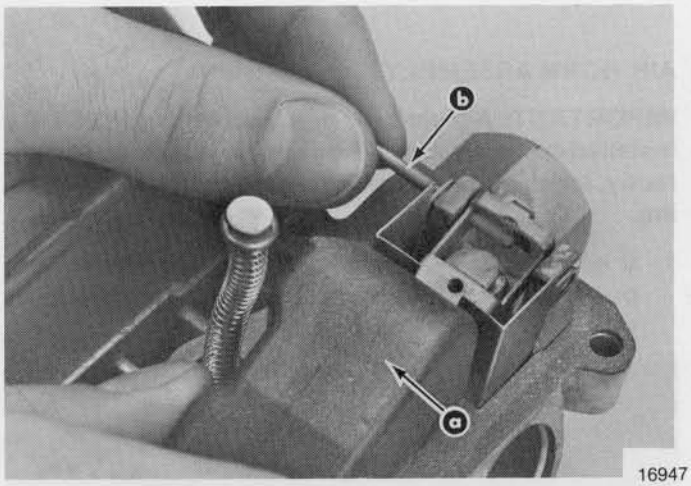


18151

a - Gasket

Installing Air Horn Gasket

7. Install float assembly and hinge pin. Pivot float assembly up-and-down on hinge pin to ensure it moves freely.

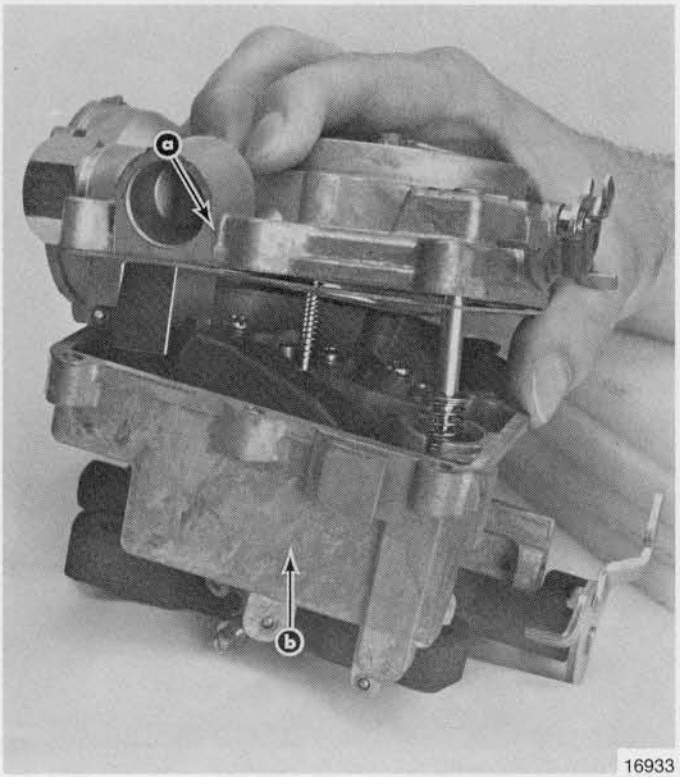


16947

a - Float Assembly
b - Float Hinge Pin

Installing Float Assembly and Hinge Pin

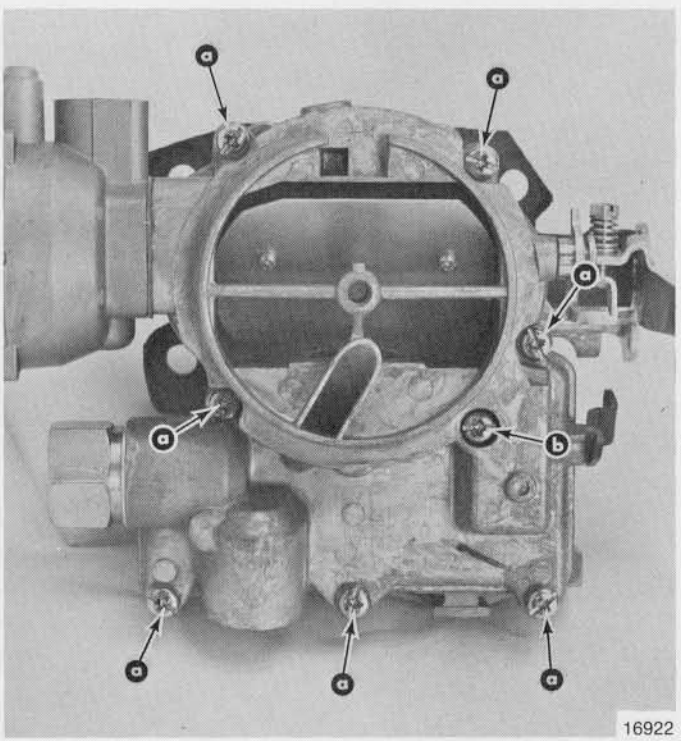
8. Place air horn on float bowl, making sure accelerator pump is correctly positioned in fuel well. Lower air horn straight down to install.



a - Air Horn
b - Float Bowl Assembly

Carefully Installing Air Horn

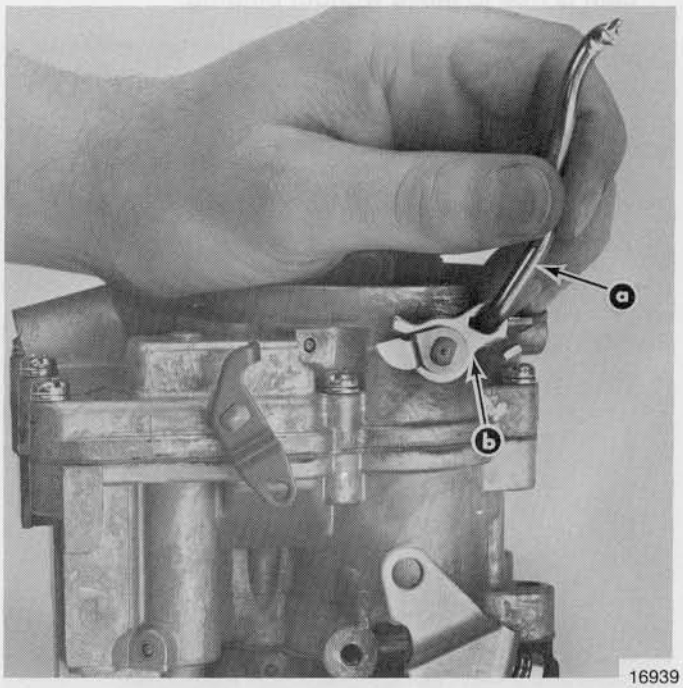
9. Install seven short and one long air horn attaching screws. Tighten screws evenly and securely.



a - Seven Short Screws
b - One Long Screw

Installing Air Horn Attaching Screws

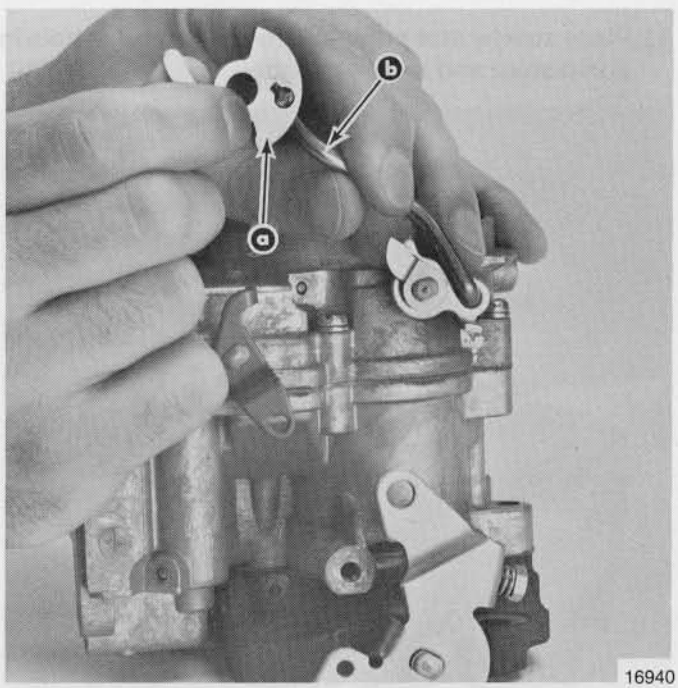
10. Place end of choke rod in choke lever and collar assembly.



a - Choke Rod
b - Choke Lever and Collar Assembly

Installing Choke Rod

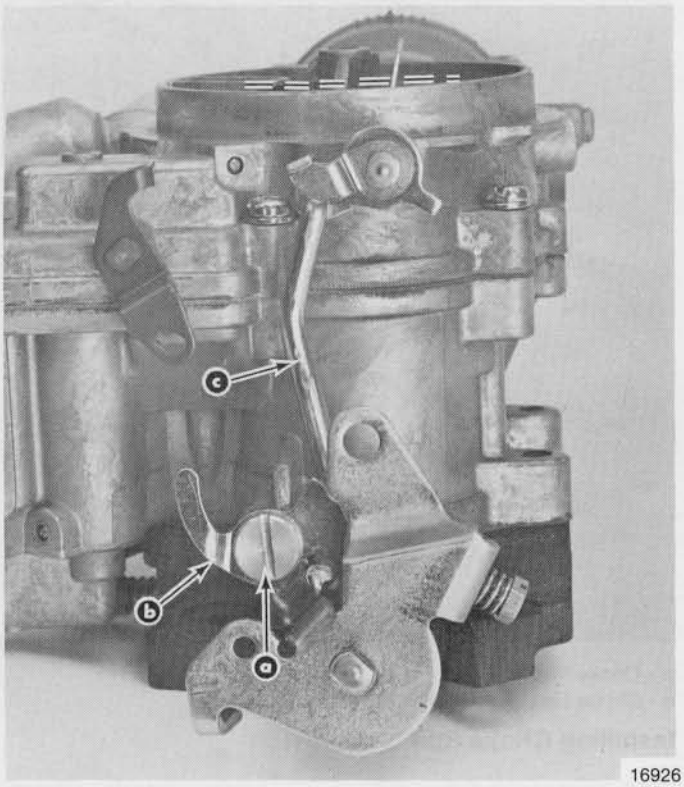
11. Place idle cam on choke rod.



a - Idle Cam
b - Choke Rod

Installing Idle Cam

12. Secure idle cam (with choke rod installed on cam) on float bowl assembly, using screw. Check that cam is free to move without binding.

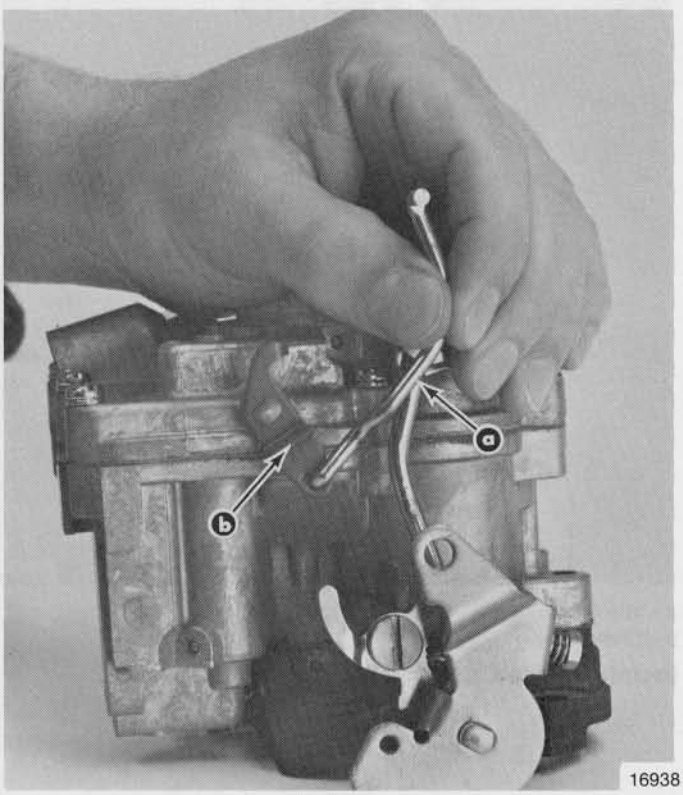


16926

a - Screw b - Idle Cam c - Choke Rod

Securing Idle Cam to Float Bowl Assembly

13. Place accelerator pump rod (end with ear) in hole in pump shaft and lever assembly.

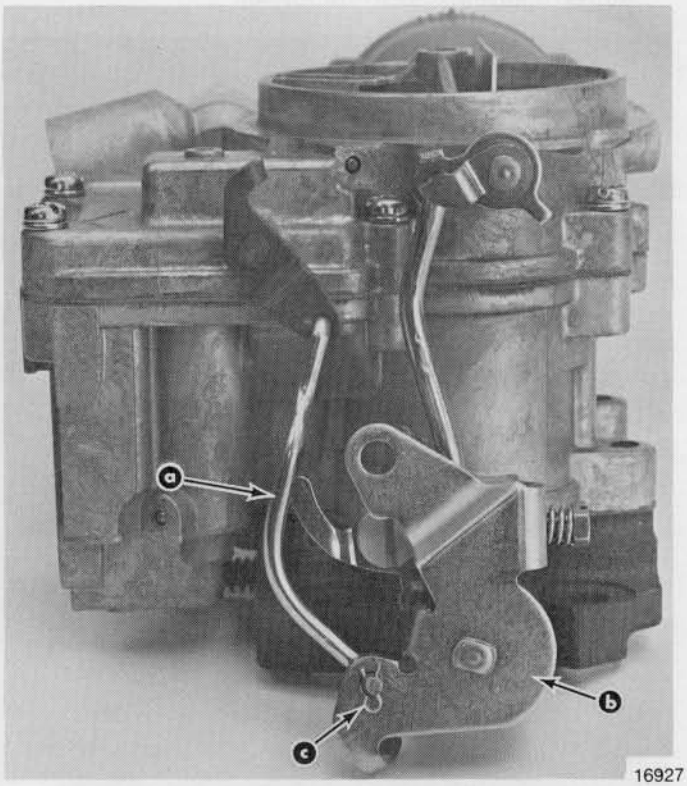


16938

a - Accelerator Pump Rod
b - Pump Shaft and Lever Assembly

Installing Accelerator Pump Rod

14. Insert remaining end of accelerator pump rod into hole in throttle lever and secure with retainer clip.



16927

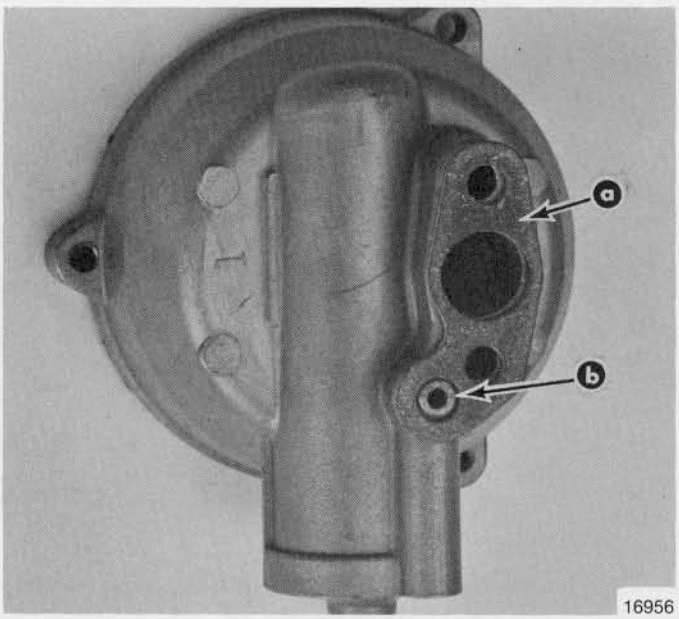
a - Accelerator Pump Rod
b - Throttle Lever
c - Retainer Clip

Securing Accelerator Pump Rod to Throttle Lever

CHOKE HOUSING ASSEMBLY

IMPORTANT: Not all MerCarb carburetors are equipped with choke housing gasket. This gasket is not necessary for choke housing installation; therefore, if replacement gasket is not available, choke housing may be installed on air horn assembly without gasket.

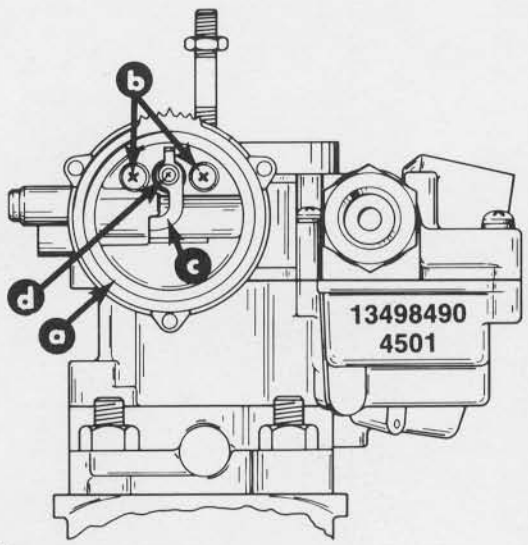
1. Place new choke housing gasket (if equipped) in position on air horn making sure that, when installing choke housing assembly, locating pin on housing inserts into hole in gasket.



a - Gasket
b - Choke Housing Assembly Gasket Locating Pin

Installing Choke Housing Assembly Gasket

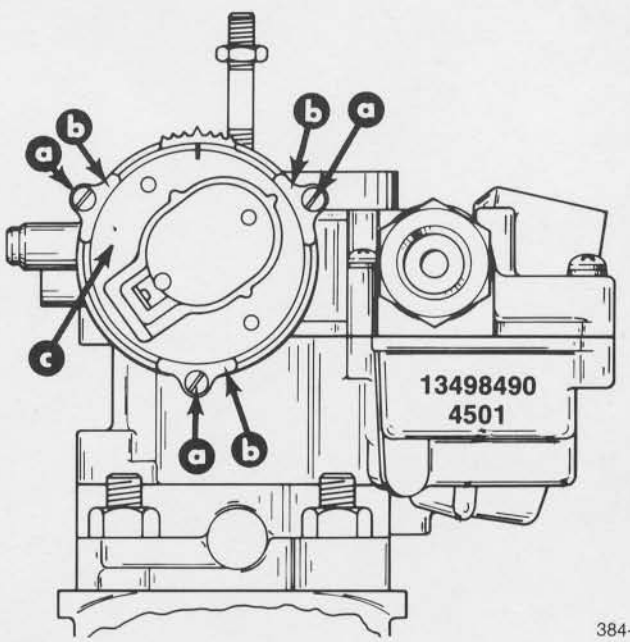
2. Secure choke housing assembly to air horn with two attaching screws. Tighten screws securely.
3. Fasten choke lever to choke shaft assembly with screw, as shown.
4. Place choke cover on choke housing. Be sure hook on end of heating coil engages with choke lever. Rotate choke cover until alignment marks (made at disassembly) line up.



a - Choke Housing Assembly
b - Choke Housing Assembly Attaching Screws
c - Choke Lever
d - Choke Lever Screw

Installing Choke Housing Assembly and Choke Lever Assembly to Air Horn

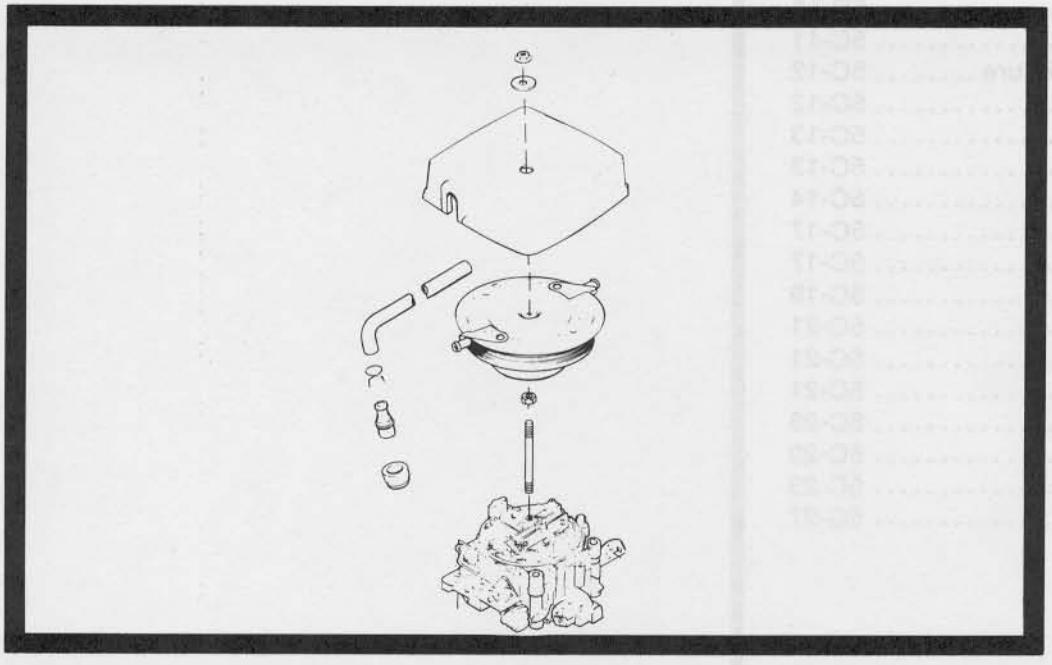
5. Secure choke cover with three screws and retainers, being sure ground terminal is fastened under bottom screw.



a - Screws
b - Retainer
c - Choke Cover

Installing Choke Cover

FUEL SYSTEM



ROCHESTER 4 BARREL

5

C

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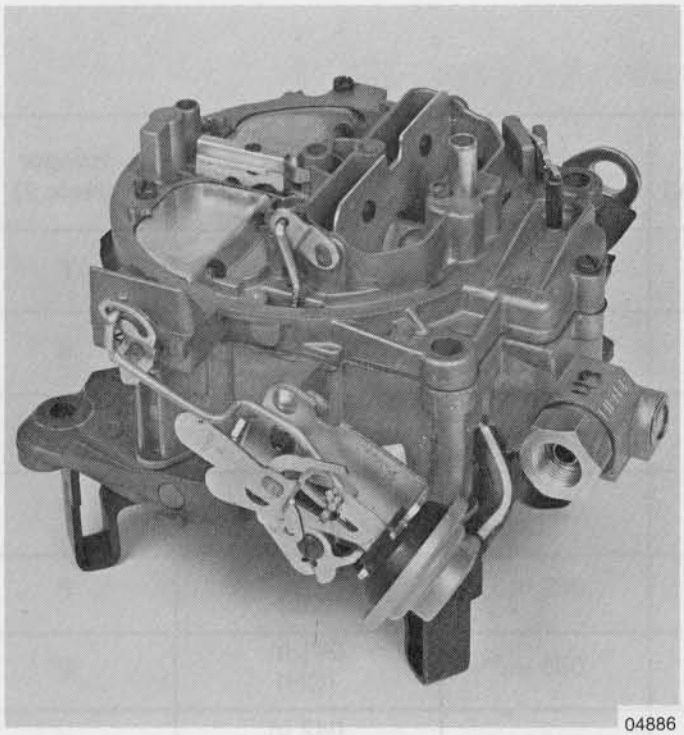
Identification



Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Carburetor to Manifold		132 (15)
Fuel Line To Carburetor	18 (24)	
Fuel Inlet Filter Nut	18 (24)	

Tools

MERCURY MARINE SPECIAL TOOLS	
91-36392	Universal Carburetor Gauge
91-59339	Tachometer

KENT-MOORE TOOL GROUP 1600 EXECUTIVE DRIVE JACKSON, MICHIGAN 49203 TEL. (517) 788-6210	
J9789-118	Carburetor Stand
J22769	Needle Valve Seat Remover

WAGNER INSTRUMENTS P.O. BOX 1217 GREENWICH, CT. 06836 (203) 869-9681	
Model G.D. 150	Gram Scale (With Round Tip)

BORROUGHS TOOL & EQUIPMENT CORP. 2429 N. BURDICK ST. KALAMAZOO, MICH. 49007 (616) 345-5163	
BT-8128 B	Float Scale
BT-8420 A	Float Level Gauge

TORX® SCREWDRIVERS

Later Rochester Quadrajet carburetors will have a "star" shaped socket in the head of the screw. A TORX® screwdriver must be used on this type of screw. The three sizes used are #9, #20 and #25.

MCM Carburetor Specifications

Model (Serial Number)	Carb Type (Note 1)	Mercury No. (Manufacturer No.)	Primary Jet Size	Primary (Secondary) Metering Rods	Hanger (Note 2)
MCM 230, 5.0 Litre LX (6899269 and Above)	Rochester 4MV	1347-8296 (17080565)	.069 In.	.042 In. (DE)	F
MCM 230TR (ALL)	Rochester 4MV	1347-8290 (17080564)	.067 In.	.036 In. (DL)	K
MCM 260, 5.7 Litre (6890706 and Above)	Rochester 4MV	1347-8292 (17080561)	.068 In.	.041 In. (DW-DE)	D
MCM 260TR (ALL)	Rochester 4MV	1347-8289 (17080562)	.069 In.	.036 In. (CH)	P
MCM 350 Magnum (ALL)	Rochester 4MV	1347-9415 (17085013)	.069 In.	.042 In. (CL)	P
MCM 300 Tempest (6668677 and Above)	Rochester 4MV	1347-7498A6 (17059280)	.068 In.	.041 In. (CH)	F
MCM 330 B-W, 7.4 Litre (6920832 and Above)	Rochester 4MV	1347-8291 (17080563)	.069 In.	.042 In. (DB)	F
MCM 454 Magnum (Alpha)	Rochester 4MV	1347-8291 (17080563)	.069 In.	.042 In. (DB)	F
MCM 370, 454 Magnum (Bravo) 6721143 and Above	Rochester 4MV	1347-7498A2 (17059280)	.068 In.	.041 In. (DA)	F
MCM 400 Cyclone (6844279 and Above)	Rochester 4MV	1347-7498A2 (17059280)	.068 In.	.041 In. (DA)	F

NOTES:

1. Rochester Quadrajets are 4MV or 4MC type. The "V" or "C" designates choke type, NOT bore size. This information supercedes all previous service bulletins and service information.
2. Hanger size may vary from this chart. Install same size hanger which was removed from the carburetor.

MIE Carburetor Specifications

Model (Serial Number)	Carb Type (Note 1)	Mercury No. (Manufacturer No.)	Primary Jet Size	Primary (Secondary) Metering Rods	Hanger (Note 2)
MIE 230, 5.0 Litre (6901030 and Above)	Rochester 4MC	1347-8290 (17080564)	.067 In.	.036 In. (DL)	K
MIE 260, 5.7 Litre (6885892 and Above)	Rochester 4MC	1347-8289 (17080562)	.069 In.	.036 In. (CH)	P
MIE 5.7 Ski (A338553 and Above)	Rochester 4MC	1347-9415 (17085013)	.069 In.	.042 In. (CL)	P
MIE 340, 7.4 Litre (A307953 and Above)	Rochester 4MC	1347-8288 (17080560)	.069 In.	.042 In. (CL)	F

NOTES:

1. Rochester Quadrajets are 4MV or 4MC type. The "V" or "C" designates choke type, NOT bore size. This information supercedes all previous service bulletins and service information.
2. Hanger size may vary from this chart. Install same size hanger which was removed from the carburetor.

UNIT OF MEASUREMENT
in. (mm)

MCM Carburetor Adjustment Specifications (Note 1)

Engine Model	MCM 230 5.0 Litre LX	MCM 230TR	MCM 260 5.7 Litre	MCM 260TR	MCM 350 Magnum	MCM 300 Tempest	MCM 330B-W MCM 454 Magnum 7.4 Litre	MCM 370 MCM 400 Cyclone 454 Magnum (1988)
Make & Model	Rochester 4MV							
Carb. Manufacturer Number	17059292 17057282 17080565	17080564	17059288 17057298 17080561	17080562	17085013	17059280	17059290 17057287 17080563	17059288 17059280
Float Level	15/64 (5.9)							
Pump Rod Hole Location	Inner							
Accelerator Pump (Note 2)	23/64 (9.1)							
Air Valve Dash Pot (Air Valve Rod)	.025 (.64)							
Vacuum Break	.080 [5/64 (2.0)]							
Air Valve Spring Wind Up	3/8 Turn 70-90 Gr.	3/8 Turn 60-75 Gr.	1/2 Turn 70-90 Gr.	3/8 Turn 70-90 Gr.	3/8 Turn 70-90 Gr.	1/2 Turn 70-90 Gr.	1/2 Turn 80-95 Gr.	5/8 Turn 70-90 Gr.
Choke Coil Rod (Note 3)	Top of Rod Even With Bottom of Hole							
Idle Mixture Screw Preliminary Setting	2-3 Turns							
Float Weight (Max)	9.88 Gr.							

NOTES: 1. All measurements are ± 1/64" (.4mm). Information contained in this chart supercedes all service bulletins printed in 1984 and earlier.

2. Accelerator pump measurement taken from flame arrestor surface to pump stem with throttle plates closed.

3. Choke valve must be closed, choke rod in bottom of choke lever slot, and choke coil rod pushed down to end of travel.

UNIT OF MEASUREMENT
in. (mm)

MIE Carburetor Adjustment Specifications (Note 1)

Engine Model	MIE 230, 5.0 Litre	MIE 5.7 Ski	MIE 260 5.7 Litre	MIE 340 7.4 Litre
Make & Model	Rochester 4MV			
Carb. Manufacturer Number	17080564	17085013	1708562	17080560
Float Level	15/64 (5.9)			
Pump Rod Hole Location	Inner			
Accelerator Pump (Note 2)	23/64 (9.1)			
Air Valve Dash Pot (Air Valve Rod)	.025 (.64)			
Vacuum Break	.080 [5/64 (2.0)]			
Air Valve Spring Wind Up	3/8 Turn 60-75 Gr.	3/8 Turn 75-85 Gr.	3/8 Turn 70-90 Gr.	3/4 Turn 80-95 Gr.
Choke Coil Rod (Note 3)	Top of Rod Even With Bottom of Hole			
Idle Mixture Screw Preliminary Setting	2-3 Turns			
Float Weight (Max)	9.88 Gr.			

NOTES: 1. All measurements are ± 1/64" (.4mm). Information contained in this chart supercedes all service bulletins printed in 1984 and earlier.

2. Accelerator pump measurement taken from flame arrestor surface to pump stem with throttle plates closed.

3. Choke valve must be closed, choke rod in bottom of choke lever slot, and choke coil rod pushed down to end of travel.

Description

The Quadrajet carburetor has 2 stages in operation. The primary (fuel inlet) side has small bores with a triple venturi set-up equipped with plain tube nozzles. Its metering principles are similar to the most plain tube carburetors which use the venturi principle. The triple venturi stack up, plus smaller primary bores, give a more stable and finer fuel control in idle and economy ranges of operation. Fuel metering in primary side is accomplished with tapered metering rods positioned by a manifold vacuum responsive piston.

Secondary side has 2 very large bores which have greatly increased air capacity to meet present day and future engine demands. Air valve principle is used in secondary side for metering control and supplements fuel flow from primary bores.

Using air valve principle, fuel is metered in direct proportion to air passing thru secondary bores.

Fuel reservoir is centrally located to avoid problems of fuel slosh causing engine turn cut-out and delayed fuel to carburetor bores. Float system uses a single float pontoon for ease in servicing the unit.

Precautions

⚠WARNING
Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING
Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING
Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

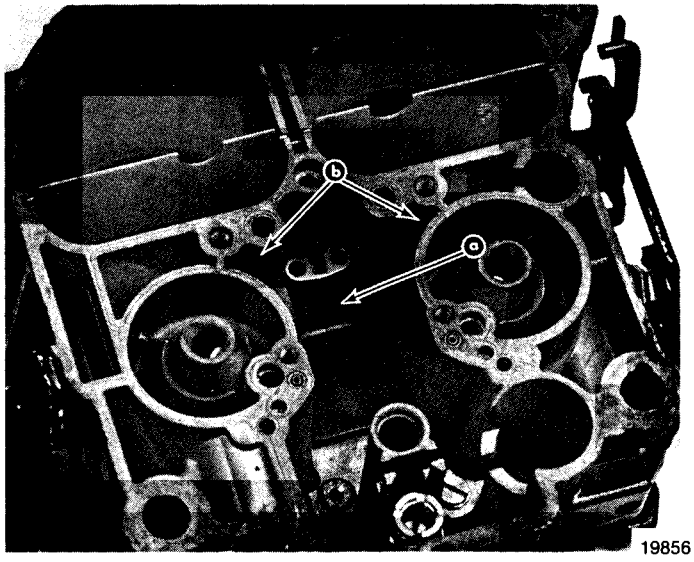
⚠WARNING
Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Important Service Information

NOZZLE DEFLECTOR, MIE 230/260/340 STRAIGHT INBOARD AND V-DRIVE

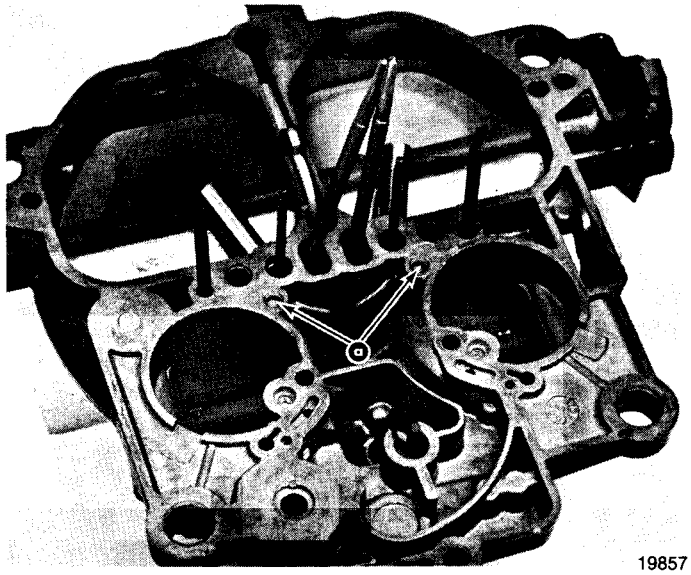
If you receive a complaint of high speed surging on a MIE engine equipped with a Quadrajet carburetor, the problem can be cured by installing a nozzle deflector (P/N 1397-9422) as shown.



19856

a - Nozzle Deflector
b - Locating Bosses

When installing the nozzle deflector, inspect the air horn for the 2 locating holes as shown. If the locating holes are in the air horn, the nozzle deflector can be installed as is. If the air horn does not have these locating holes, the 2 bosses on the nozzle deflector must be carefully removed so the air horn will fit flush on the float bowl.



19857

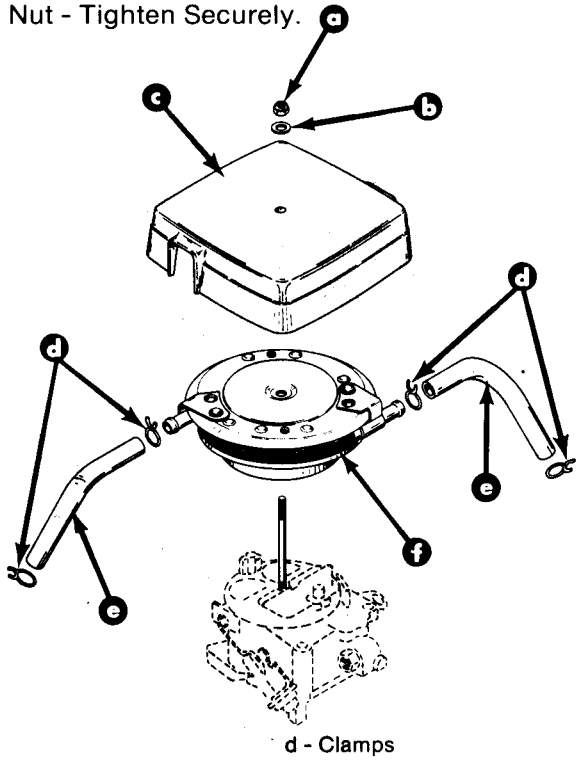
a - Locating Holes

Maintenance

Flame Arrestor

NOTICE
Refer to "Precautions" in this section BEFORE proceeding.

1. Remove (in the following order):
   a. Nut
   b. Sealing Washer
   c. Carburetor Cover
   d. Hose Clamps and Crankcase Ventialtion Hoses - From Flame Arrestor and Rocker Arm Covers
   e. Flame Arrestor - Lift from Carburetor
2. Clean and Inspect:
   a. Clean flame arrestor in solvent and blow dry with compressed air.
   b. Clean crankcase ventilation hoses
   c. Inspect crankcase ventilation hose for cracks or deterioration, and replace if neccessry.
3. Install (in the following order):
   a. Flame Arrestor - Place on Carburetor
   b. Crankcase Ventilation Hose and Hose Clamps -To Flame Arrestor and Rocker Arm Covers
   c. Carburetor Cover
   d. Sealing Washer
   e. Nut - Tighten Securely.



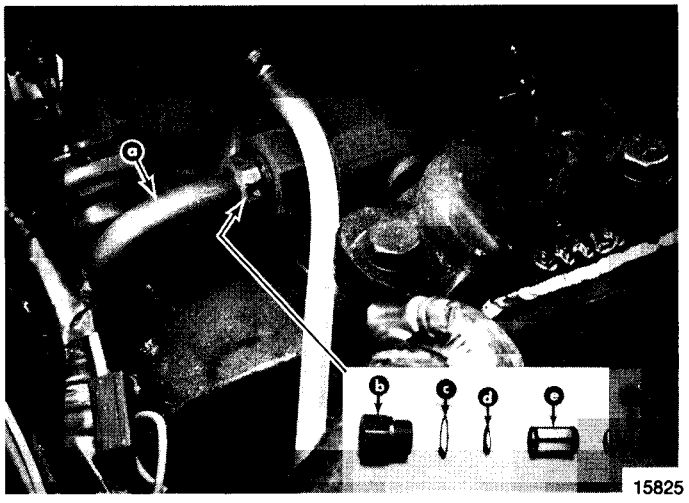
a - Nut
b - Washer
c - Carburetor Cover
d - Clamps
e - Crankcase Ventilation Hoses
f - Flame Arrestor

Flame Arrestor with Carburetor Cover

Fuel Filter

NOTICE
Refer to "Precautions" in this section BEFORE proceeding.

1. Remove;
   - Fuel line from fuel inlet filter nut
   - Fuel inlet filter nut
   - Large gasket
   - Filter
   - Spring
   - Small gasket - From inside filter nut



a - Fuel Line
b_1 - Fuel Inlet Filter Nut
c - Gasket (Large)
d - Gasket (Small)
e - Filter
f - Spring

Changing Fuel Filter

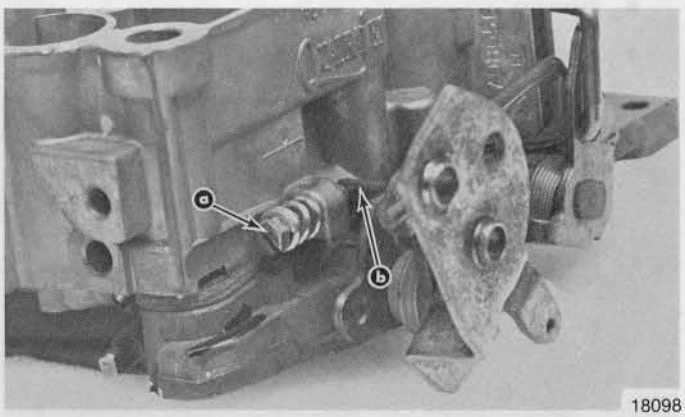
2. Clean filter nut and spring.
3. Install the following;
   - Spring - Place in carburetor body
   - Filter - Open end to inlet filter nut
   - Small gasket - Place inside filter nut
   - Large gasket - Place over filter nut
   - Fuel inlet filter nut - Tighten to specifications
   - Fuel line - Tighten to specifications

Adjustments

NOTICE
Refer to "Precautions" in this section BEFORE proceeding.

Accelerator Pump

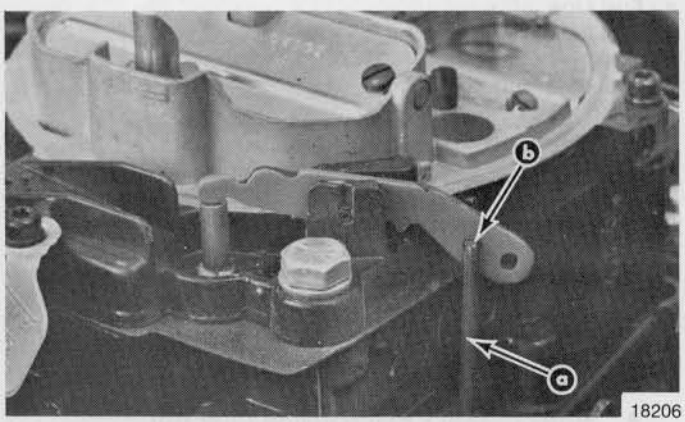
1. Back out idle stop screw until it no longer contacts throttle lever.



18098

a - Idle Stop Screw
b - Throttle Lever
Backing Out Idle Stop Screw

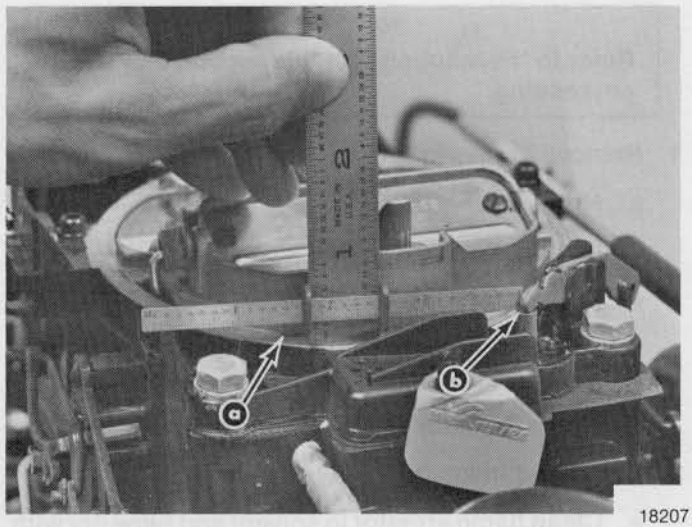
2. Pump rod must be in inner hole of lever.



18206

a - Pump Rod
b - Inner Hole
Pump Rod Location

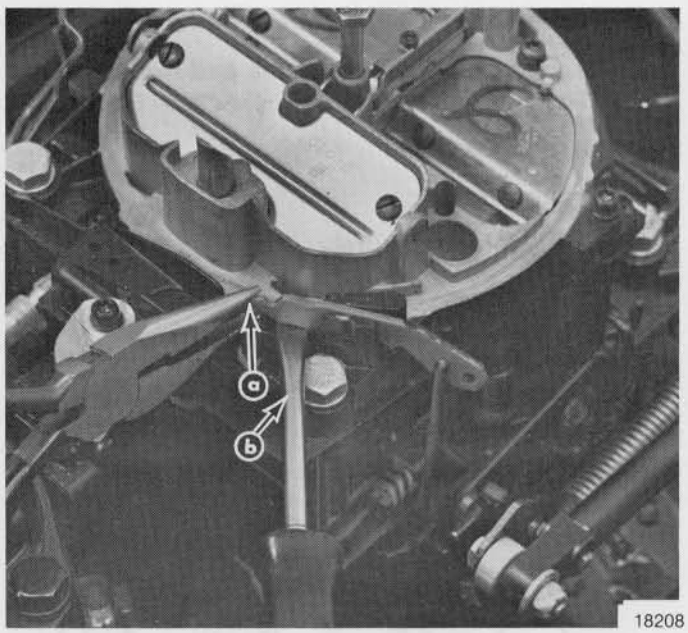
3. Close throttle valves completely and measure from flame arrestor mounting surface to top of pump plunger stem.



18207

a - Flame Arrestor Mounting Surface
b - Pump Plunger Stem
Measuring pump plunger Height

4. While supporting lever, bend tip of pump lever to obtain specified dimension.

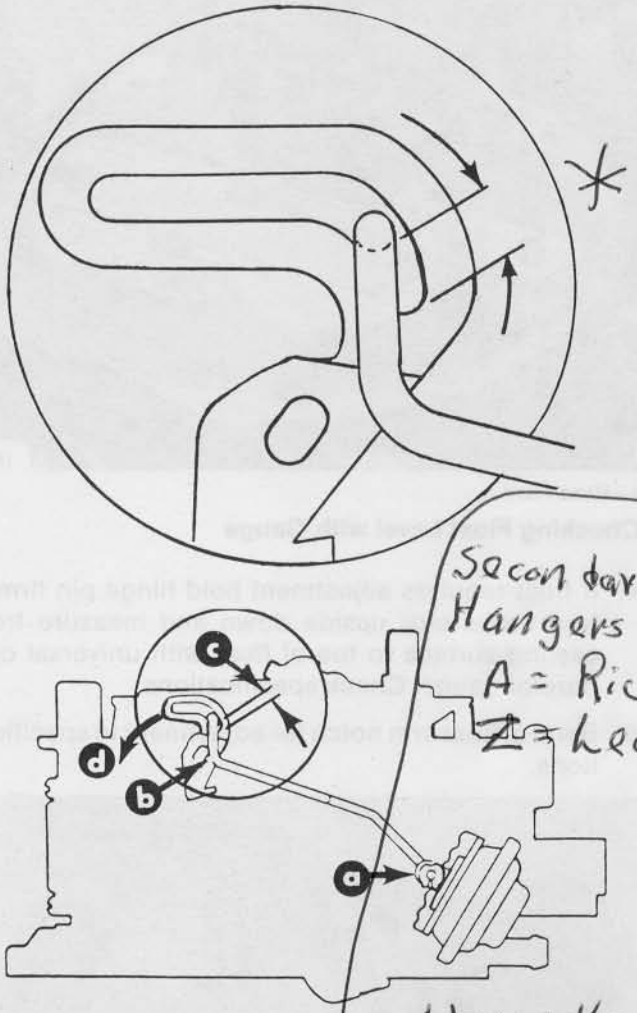


18208

a - Tip of Pump Lever
b - Support as Shown
Adjusting Pump Plunger Height

Air Valve Dashpot

1. Seat vacuum break diaphragm and close air valve completely. Bend rod to adjust gap to specifications.

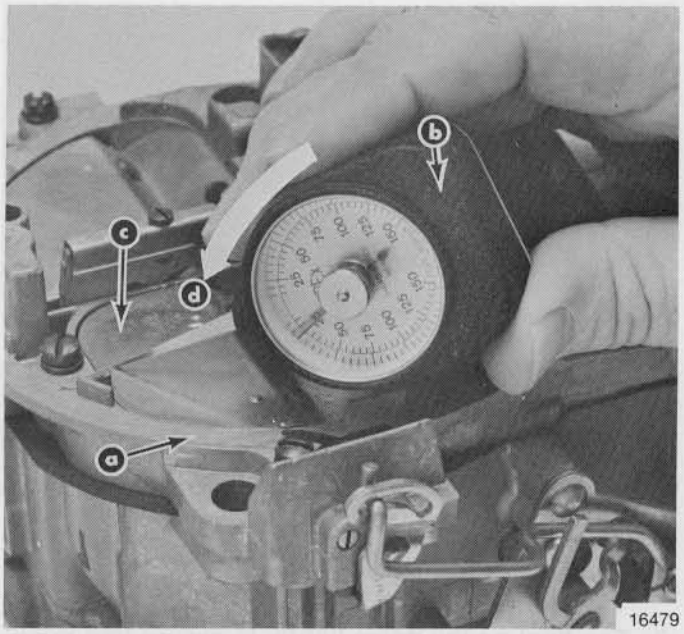


a - Push in Completely
b - Bend Here to Adjust
c - Specified Gap
d - Fully Closed

Adjusting Dashpot Link Rod

Air Valve Spring Windup

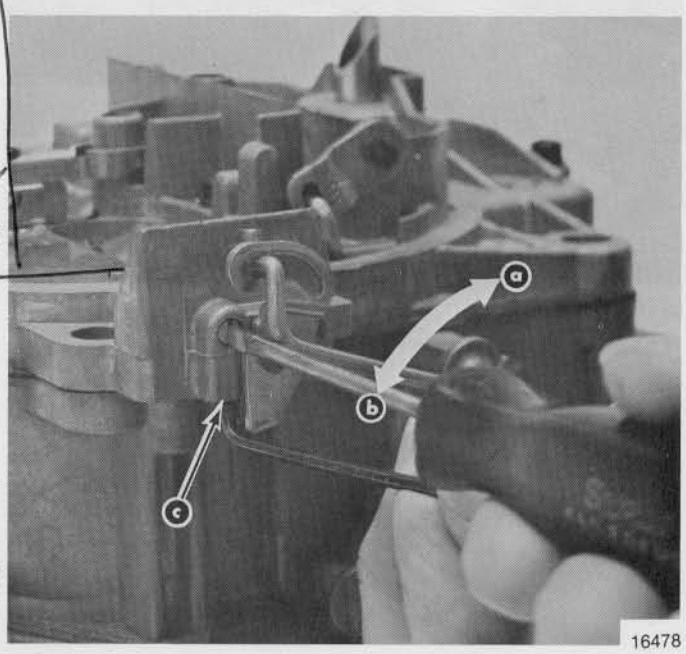
1. Rotate gram scale until air valve begins to open, check scale reading.



a - Carburetor Casting
b - Gram scale
c - Contact Area of Arm on Air Valve
d - Rotate

Checking Air Valve

2. To adjust spring windup, hold tension spring screw and loosen allen head screw.
3. Adjust tension and retighten allen screw securely.

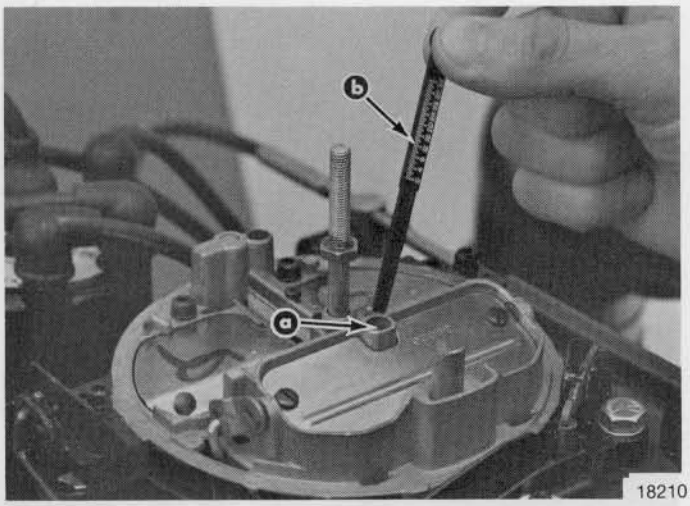


a - Increase
b - Decrease
c - Loosen Allen Head Screw

Adjusting Air Valve

Float Level

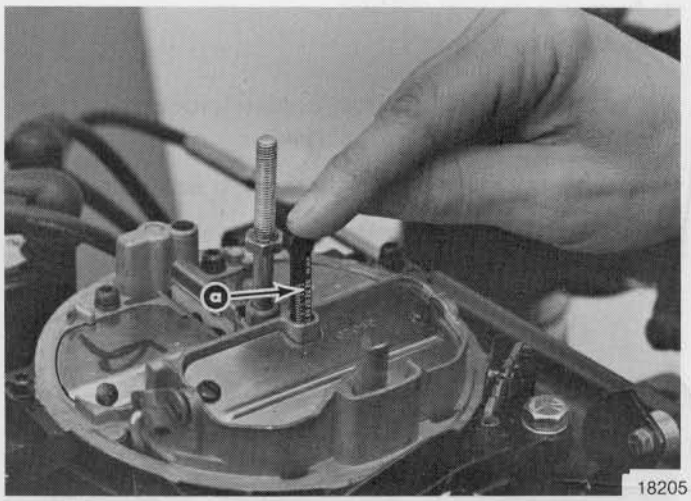
1. Start engine to fill float bowl, run at idle and insert float gauge into hole next to flame arrestor stud.



a - Gauge Hole
b - Gauge (BT-8420A)

Installing Float Gauge

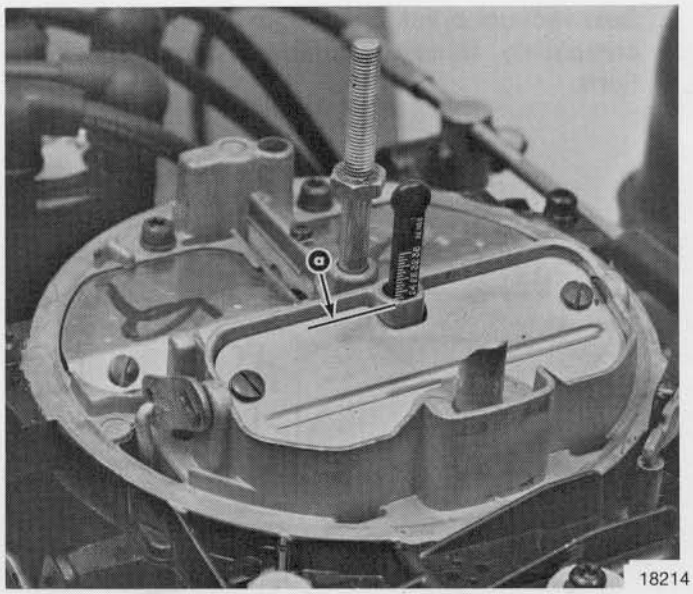
2. Tap float gauge down lightly to assure free movement.



a - Gauge

Tapping Float Gauge

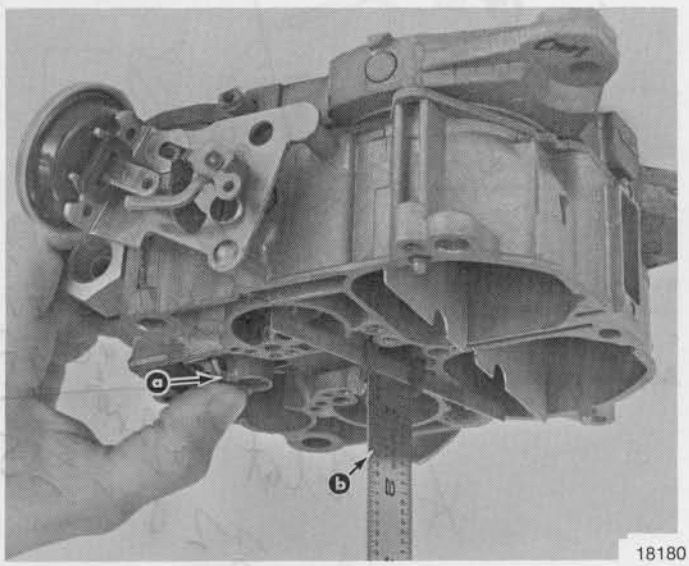
3. Take gauge reading at top of carburetor casting.



a - Read Here

Checking Float Level with Gauge

4. If float requires adjustment hold hinge pin firmly, turn carburetor upside down and measure from casting surface to toe of float with universal carburetor gauge. Check specifications.
5. Bend at float arm notch for adjustment to specifications.

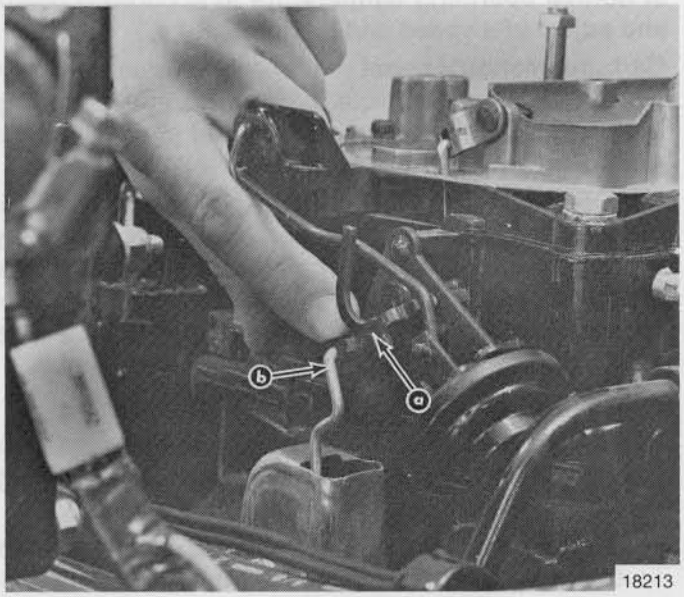


a - Hinge Pin
b - Universal Carburetor Gauge

Adjusting Float

Choke Coil Rod

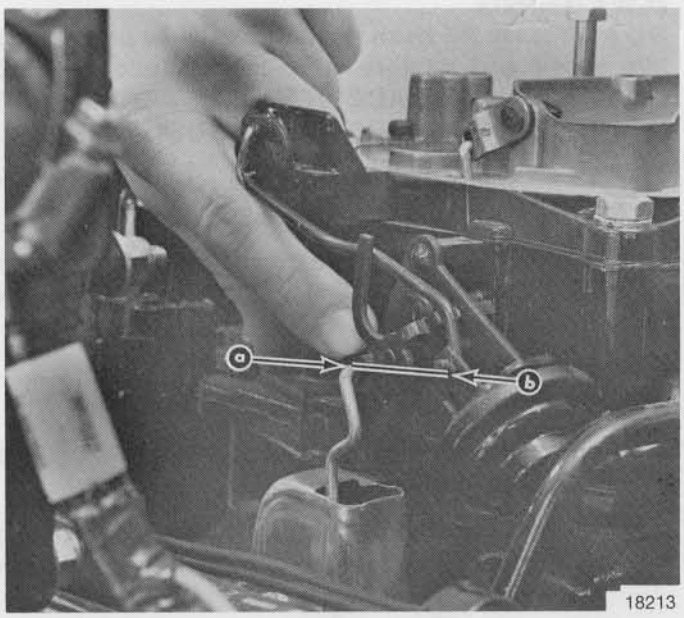
1. Push choke coil rod down.



a - Vacuum Break Choke Lever
b - Choke Coil Rod

Pushing Choke Rod Down

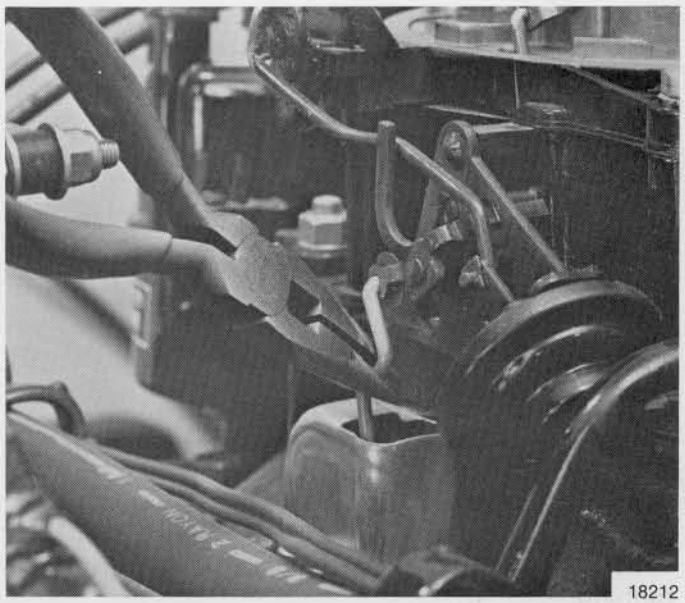
2. Choke coil rod top must be even with bottom of hole in vacuum break choke lever.



a - Top of Rod
b - Bottom of Hole

Checking Choke Rod Adjustment

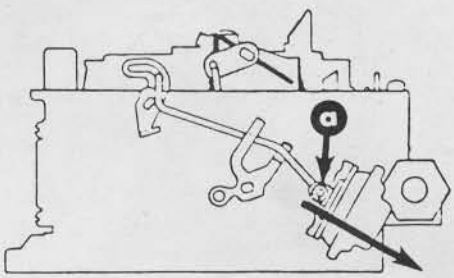
3. Bend rod to adjust.



Bending Choke Coil Rod

Vacuum Break

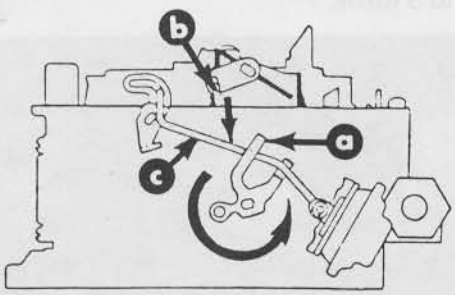
1. Seat vacuum break control diaphragm.



a - Vacuum Break Control Diaphragm

Seating Vacuum Break Control Diaphragm

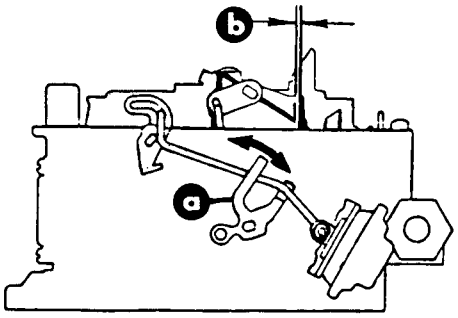
2. Rotate vacuum break choke lever counterclockwise until tang contacts vacuum break rod. Choke rod must be at bottom of choke shaft lever slot.



a - Tang
b - Choke Rod
c - Vacuum Break Rod

Rotating Choke Lever

3. Bend tang as necessary to obtain specified choke valve gap.



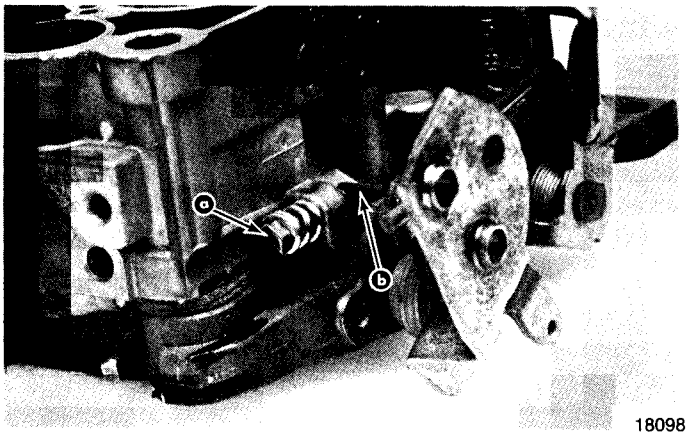
a - Tang
b - Specified Gap

Checking Vacuum Break and Unloader Adjustment

Preliminary Idle Speed and Mixture

Initial start setting, make final adjustments with engine running.

1. Turn idle stop screw until contact with throttle lever.

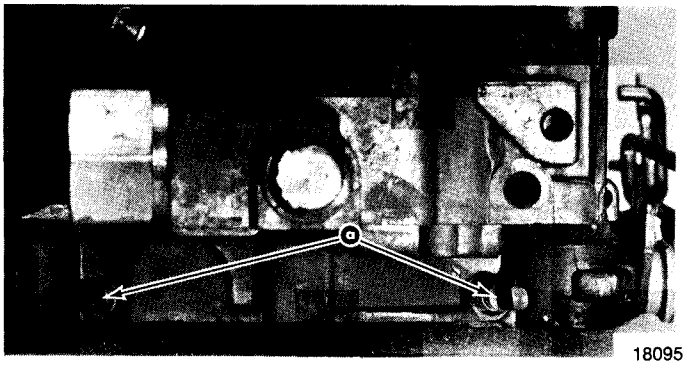


18098

a - Idle Stop Screw
b - Throttle Lever

Idle Stop Screw and Throttle

2. Turn idle needles until LIGHTLY seated then back out 2 to 3 turns.



18095

a - Idle Needles

Idle Mixture Needles

IMPORTANT: Do not turn idle mixture screws tightly against seat, as damage to seat and/or needle may result.

Final Idle Speed and Mixture

IMPORTANT: Boat MUST BE in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles smoothly, with boat in the water, engine at normal operating temperature and drive unit in forward gear. To adjust idle speed and mixture, proceed as follows:

IMPORTANT: DO NOT attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

1. Connect a shop tachometer to engine.

IMPORTANT: DO NOT turn idle mixture needles tightly into seat, as damage to needle and/or seat may result.

2. If a new or rebuilt carburetor has been installed, turn each idle mixture needle until it LIGHTLY contacts seat, then back out 2 to 3 turns. This will provide a sufficient setting to allow starting the engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠WARNING

DO NOT leave the helm unoccupied while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable brass barrel from anchor stud. BE SURE NOT TO LOSE SPACER ON ANCHOR STUD.
6. Adjust idle speed adjustment screw to obtain specified RPM.
7. With engine running at specified RPM, adjust idle mixture needles as follows:
   a. Turn idle mixture needle inward (clockwise) until the engine speed begins to drop due to lean mixture.
   b. Turn idle mixture screw outward (counterclockwise) until the speed begins to drop due to a rich mixture.
   c. Turn screw inward to a point between these two extremes to obtain maximum engine smoothness and RPM.
   d. Repeat procedure with other needle.
   e. Readjust idle speed adjusting screw, if necessary, to obtain specified RPM.

IMPORTANT: Refer to "Section 2" for throttle cable installation and adjustment.

Repair

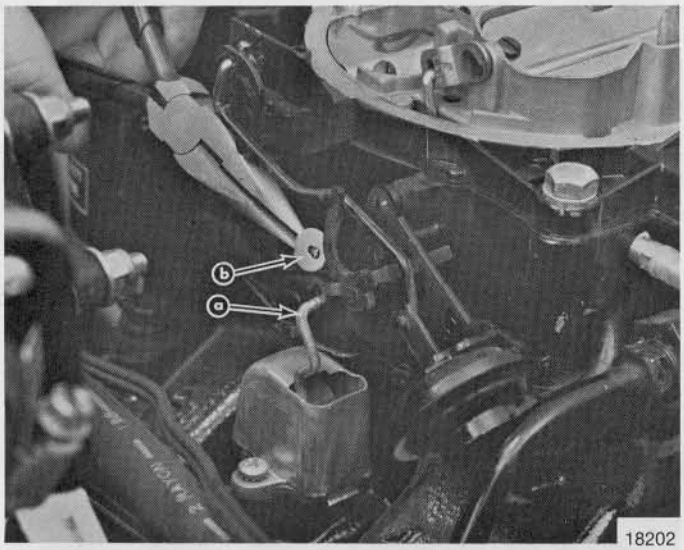
NOTICE

Refer to "Precautions" in this section BEFORE proceeding.

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may, then, be inspected for contamination as carburetor is disassembled.

Removal

1. Remove flame arrestor.
2. Disconnect choke spring rod.

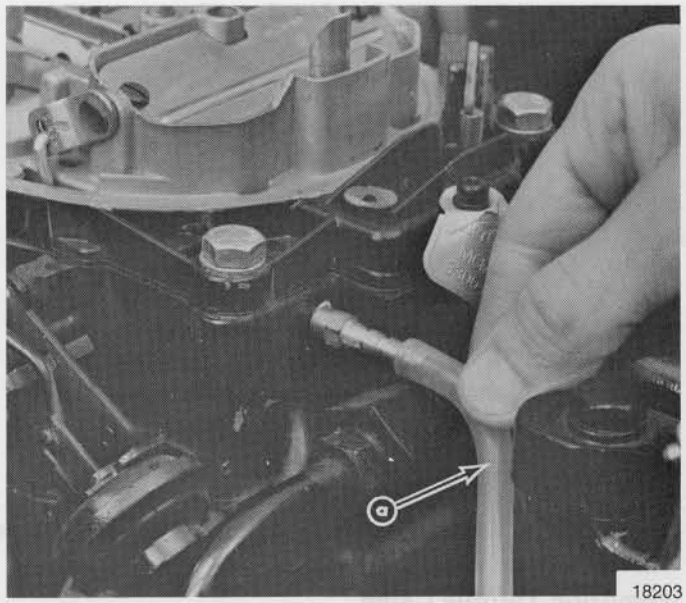


18202

a - Choke Rod
b - Clip

Removing Choke Spring Rod

3. Disconnect sight tube (if equipped).



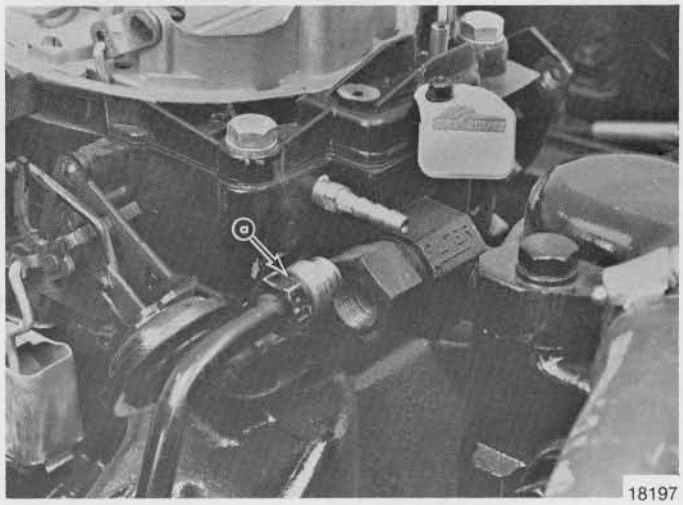
18203

a - Sight Tube

Removing Sight Tube

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

4. Turn off fuel supply at the fuel tank.
5. Disconnect fuel line.

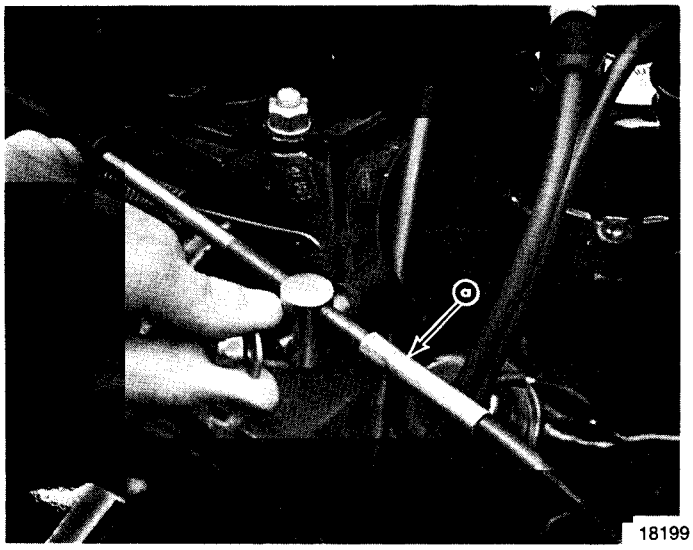


18197

a - Fuel Line

Removing Fuel Line

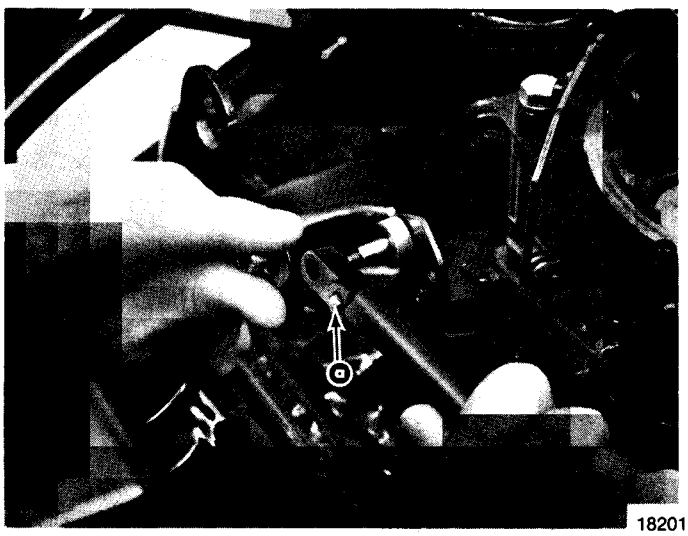
6. Disconnect throttle cable.



a - Throttle Cable

Removing Throttle Cable

7. Disconnect cable end guide.



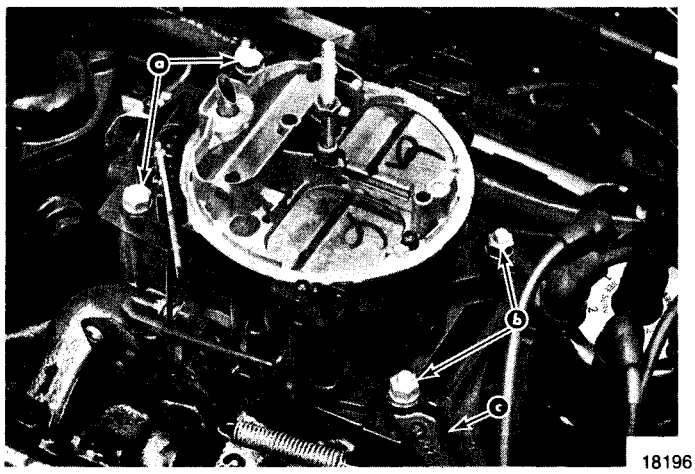
a- Cable End Guide

Removing Cable End Guide

8. Remove retaining nuts and bolts, remove carburetor and cable bracket.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

9. Remove old gasket from carburetor and manifold.

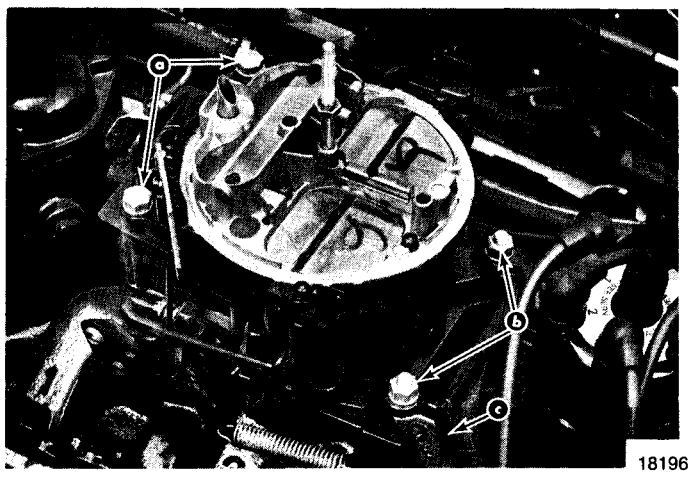


a - Bolts
b - Nuts
c - Cable Bracket

Removing Carburetor

Installation

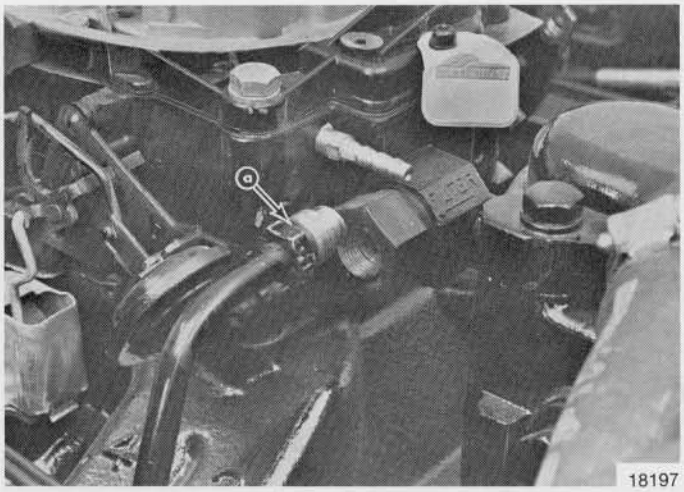
1. Install new gasket onto manifold.
2. Install carburetor and throttle bracket and torque to specifications.



a - Mounting Bolts
b - Nuts
c - Throttle Bracket

Installing Carburetor

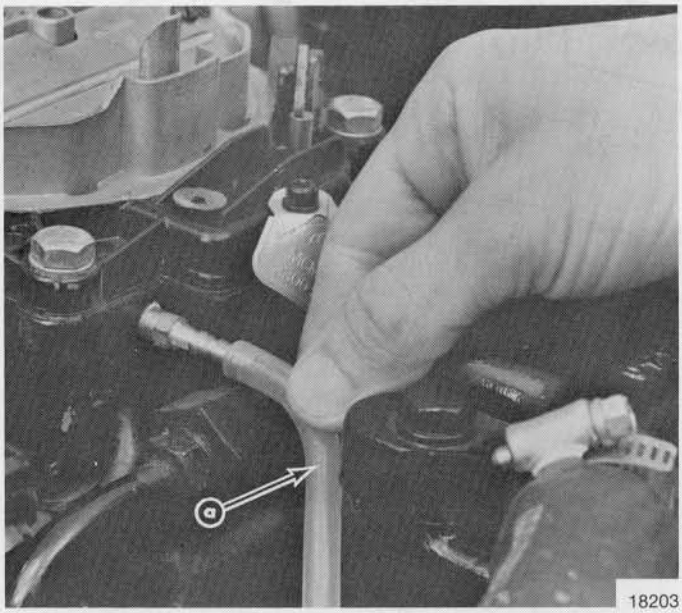
3. Connect fuel line and torque to specifications.



a - Fuel Line

Connecting Fuel Line

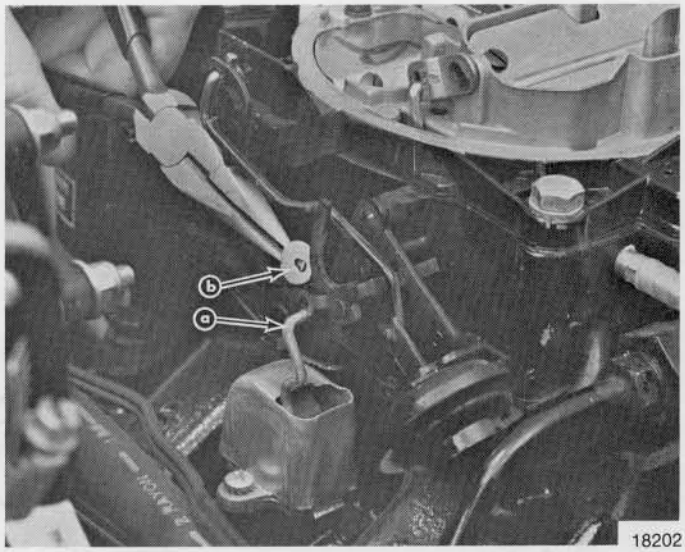
4. Connect fuel sight tube.



a - Sight Tube

Connecting Sight Tube

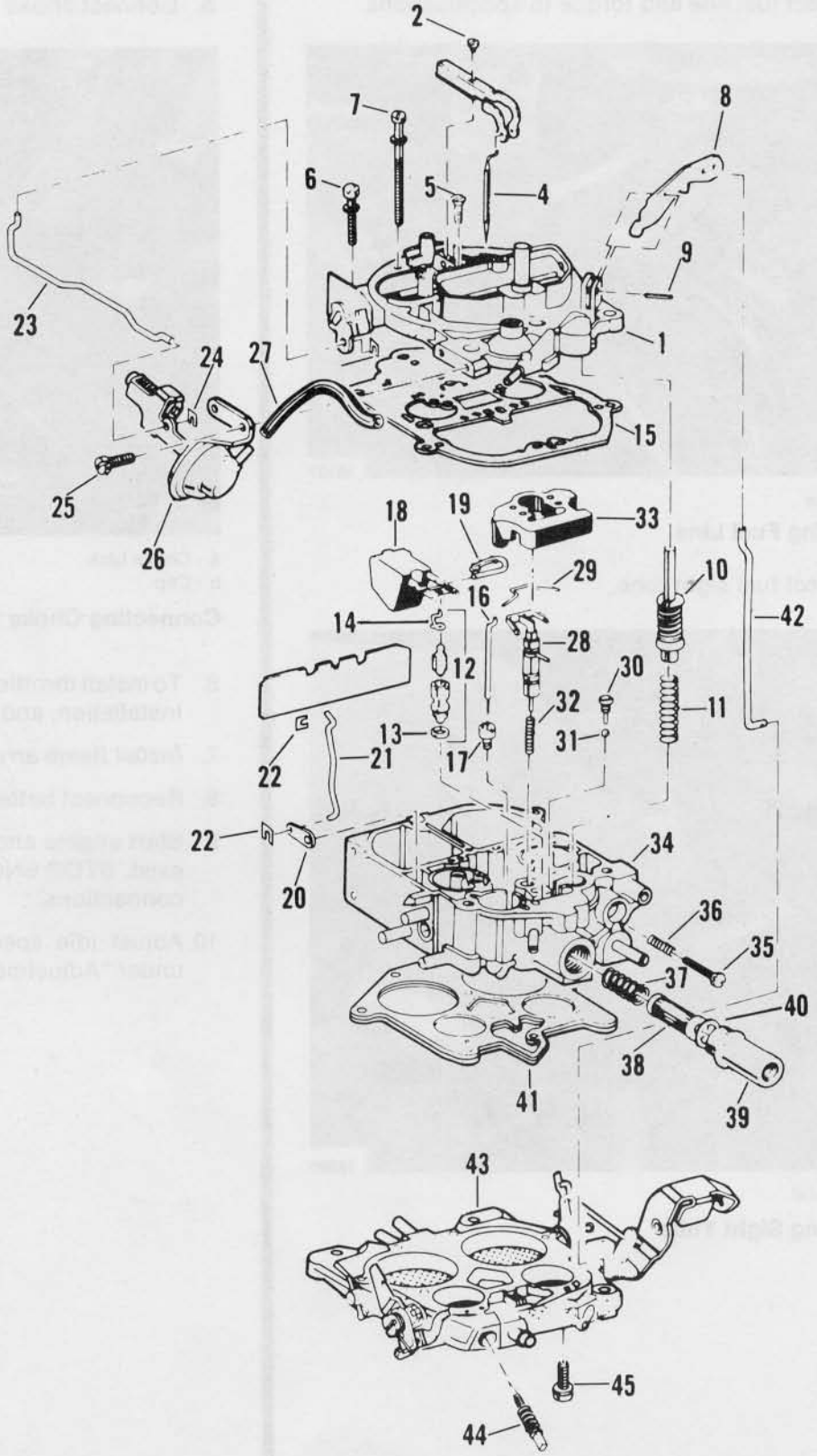
5. Connect choke link and install retaining clip.



a - Choke Link
b - Clip

Connecting Choke Spring Rod

6. To install throttle cable refer to "Section 2, Removal, Installation, and Alignment".
7. Install flame arrestor and tighten securely.
8. Reconnect battery cables to battery.
9. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
10. Adjust idle speed and idle mixture, as outlined under "Adjustments" preceding.



1 - Air Horn Assembly
2 - Screw
3 - Hanger
4 - Metering Rod, secondary
5 - Screw
6 - Screw
7 - Screw
8 - Lever
9 - Roll Pin
10 - Pump
11 - Spring
12 - Needle and Seat
13 - Gasket
14 - Pull Clip
15 - Gasket
16 - Metering Rod, primary
17 - Jet, primary
18 - Float Assembly
19 - Pin, hinge - float
20 - Lever, intermediate choke
21 - Rod
22 - Clip
23 - Rod
24 - Clip
25 - Screw
26 - Control
27 - Hose
28 - Power Piston
29 - Retainer, power piston
30 - Retainer, pump discharge ball
31 - Ball, pump discharge
32 - Spring, power piston
33 - Insert, float bowl
34 - Float Bowl
35 - Screw, idle stop
36 - Spring, idle stop screw
37 - Spring, filter nut
38 - Filter, fuel inlet
39 - Nut, fuel inlet
40 - Gasket
41 - Gasket
42 - Rod
43 - Throttle Body
44 - Idle Needle
45 - Screw

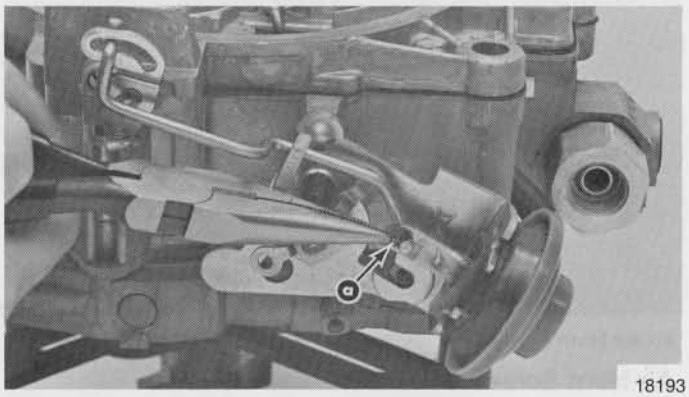
Exploded View - 4MV/4MC Quadrajet (Rochester Carburetor)

Disassembly

IMPORTANT: Place carburetor on a holding fixture to prevent throttle valve damage.

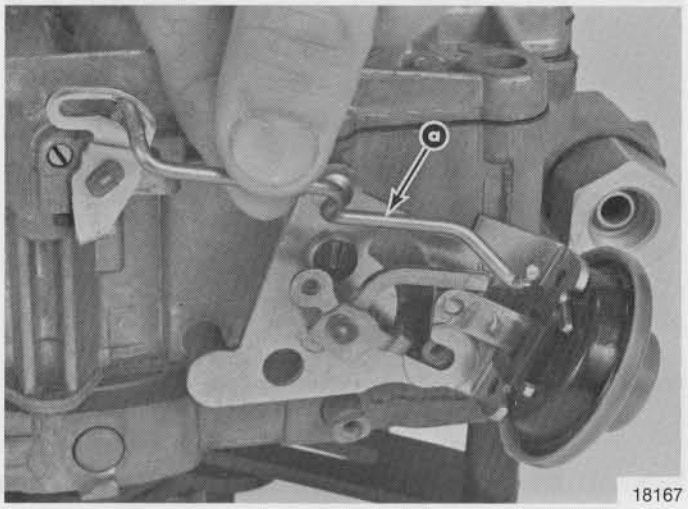
AIR HORN

1. Remove vacuum pump rod clip and rod.



a - Rod Clip

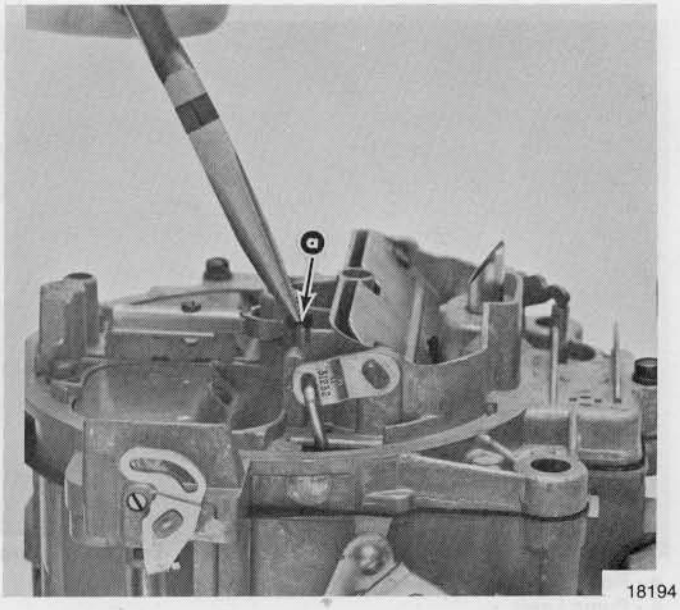
Removing Clip



a - Rod

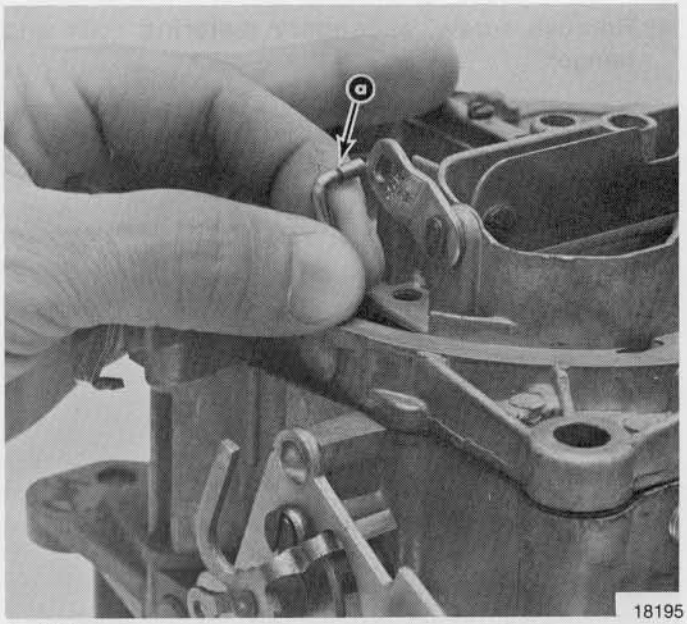
Removing Vacuum Pump Rod

2. Remove choke shutter clip and rod.



a - Clip

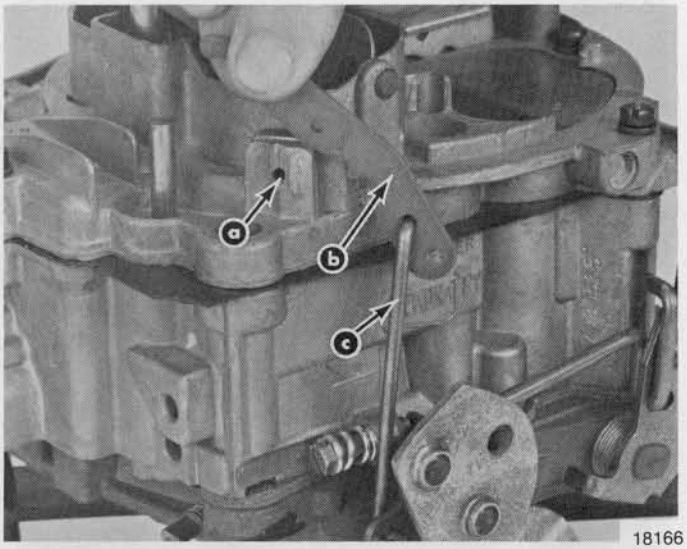
Removing Choke Rod Clip



a - Rod

Removing Choke Rod

3. Drive roll pin back and remove accelerator pump lever and rod.

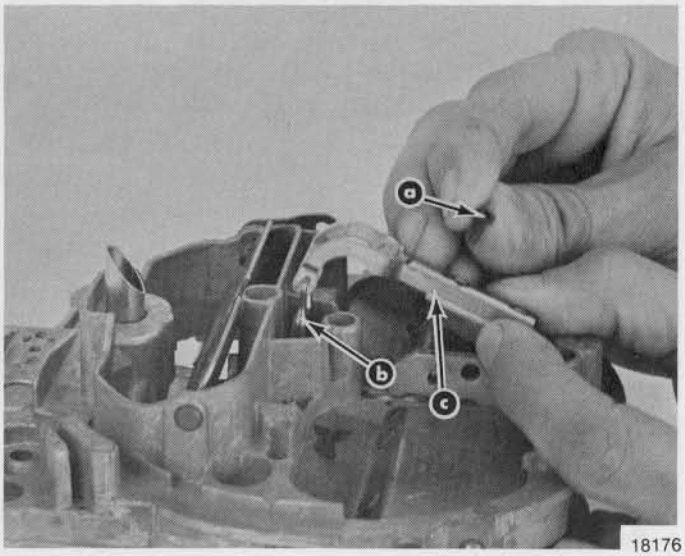


18166

a - Roll Pin (Not Shown)
b - Pump Lever
c - Rod

Removing Accelerator Pump Lever

4. Remove screw, secondary metering rods and hanger.

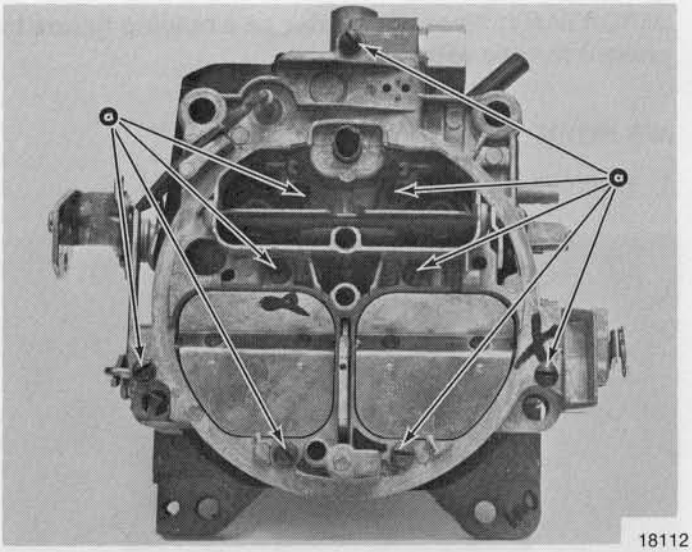


18176

a - Screw
b - Metering Rods
c - Hanger

Removing Metering Rods and Hanger

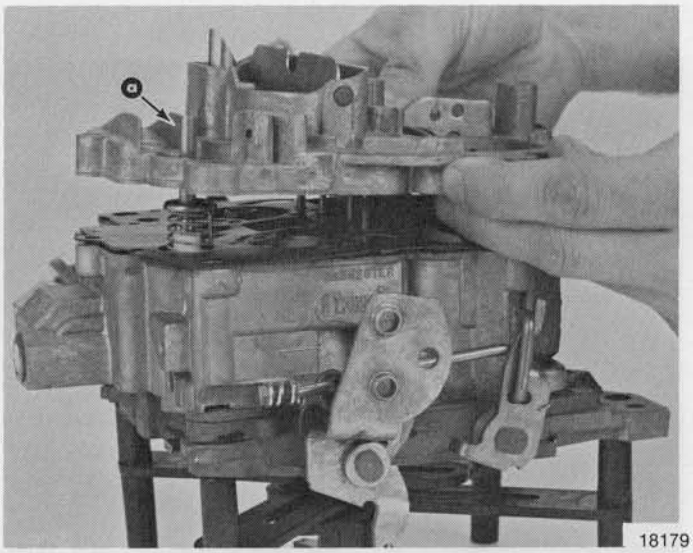
5. Remove air horn screws and air horn.



18112

a - Air Horn Screws

Air Horn Screws



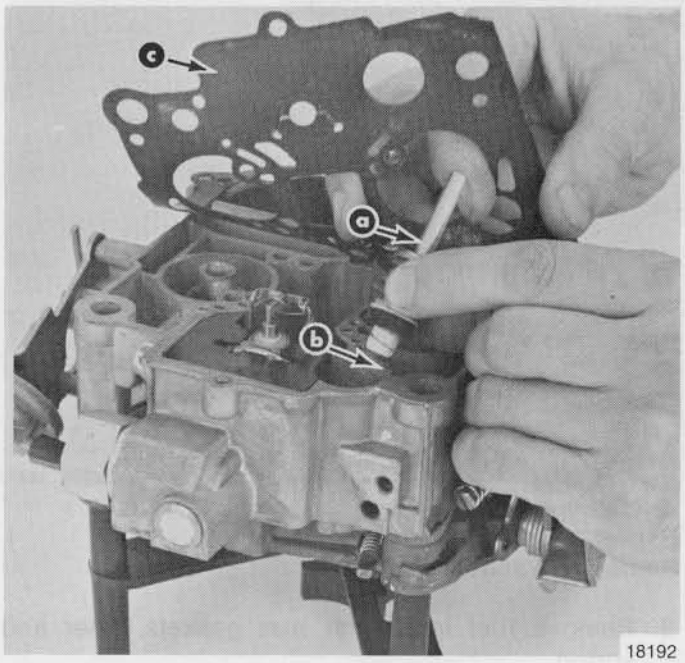
18179

a - Air Horn

Removing Air Horn

FLOAT BOWL

1. Remove pump plunger, return spring and gasket.

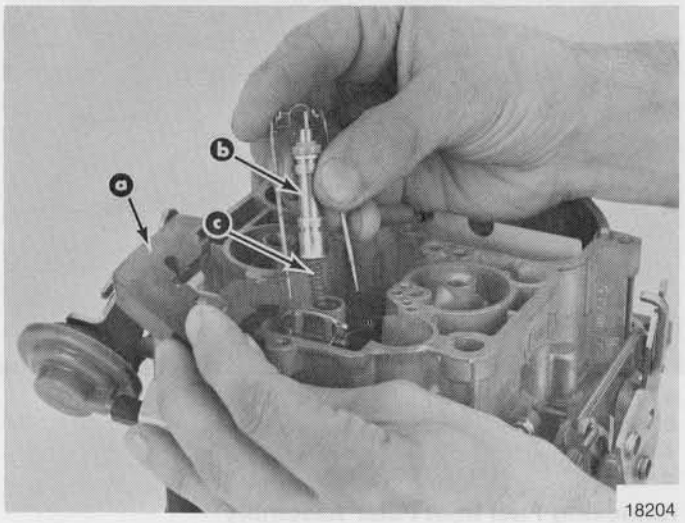


18192

a - Pump Plunger
b - Return Spring
c - Gasket

Removing Gasket and Accelerator Pump.

2. Remove insert block, power piston and spring.

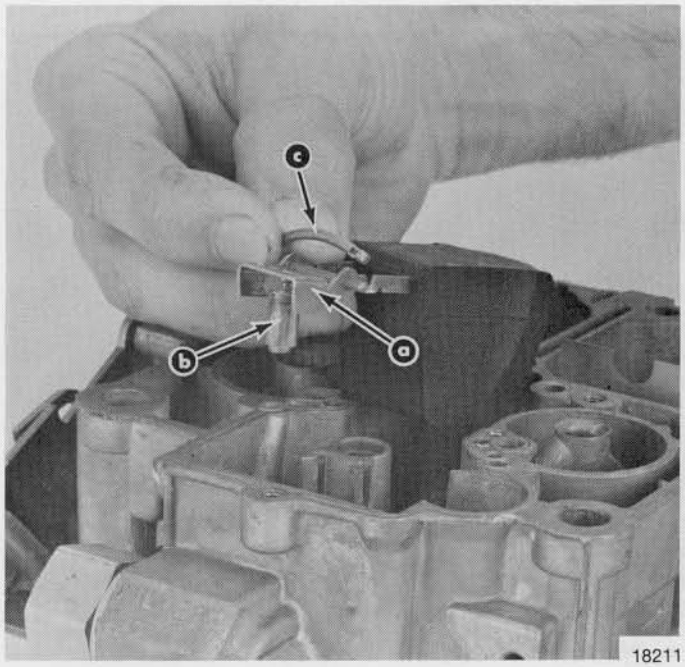


18204

a - Insert Block
b - Power Piston
c - Spring

Removing Insert Block and Power Piston

3. Remove float assembly, needle and retaining pin.

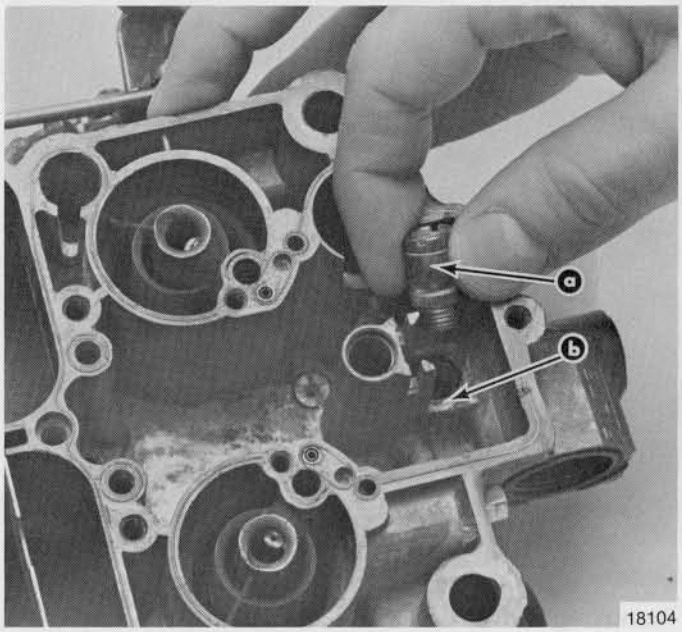


18211

a - Float Assembly
b - Needle
c - Retaining Pin

Removing Float and Inlet Needle

4. Remove fuel inlet seat and gasket.

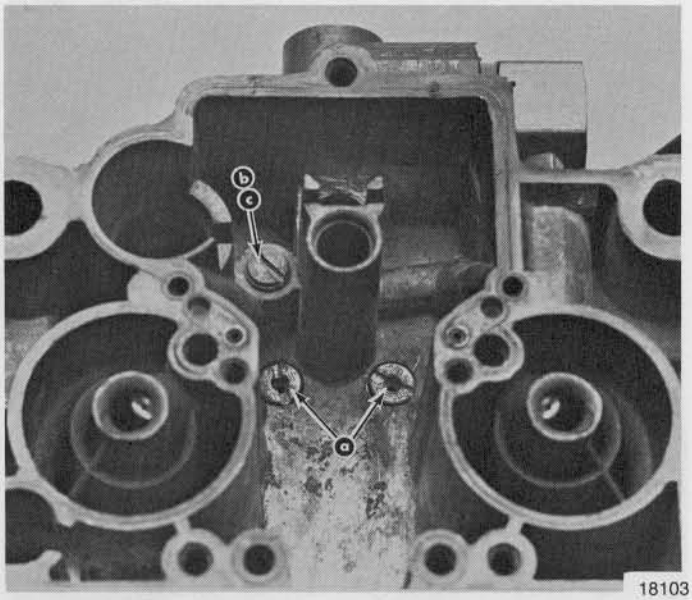


18104

a - Fuel Inlet Seat
b - Gasket

Removing Inlet Seat

5. Remove primary metering jets, pump discharge check ball retainer and check ball.

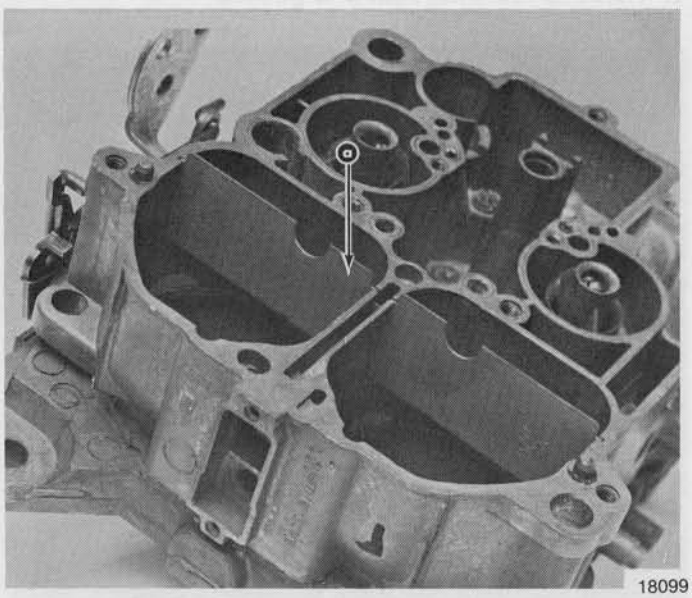


18103

a - Primary Metering Jets
b - Pump Discharge Retainer
c - Check Ball (Not Visible)

Removing Primary Jets and Retainer and Check Ball

6. Remove Baffle.

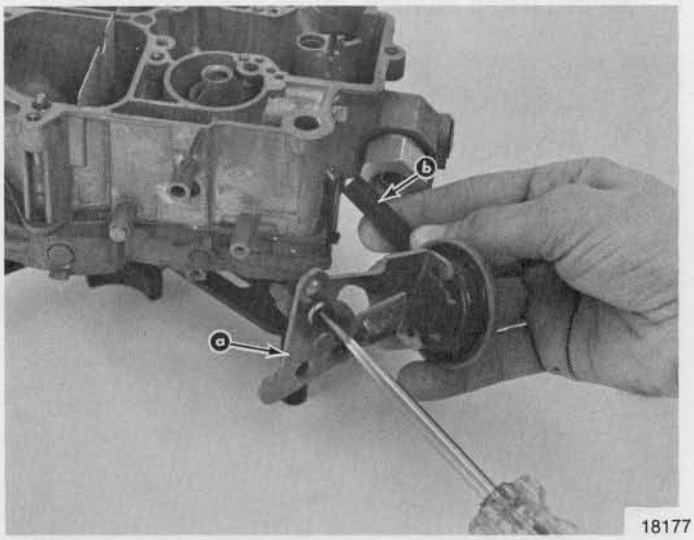


18099

a - Baffle

Removing Baffle

7. Remove vacuum control assembly and hose.

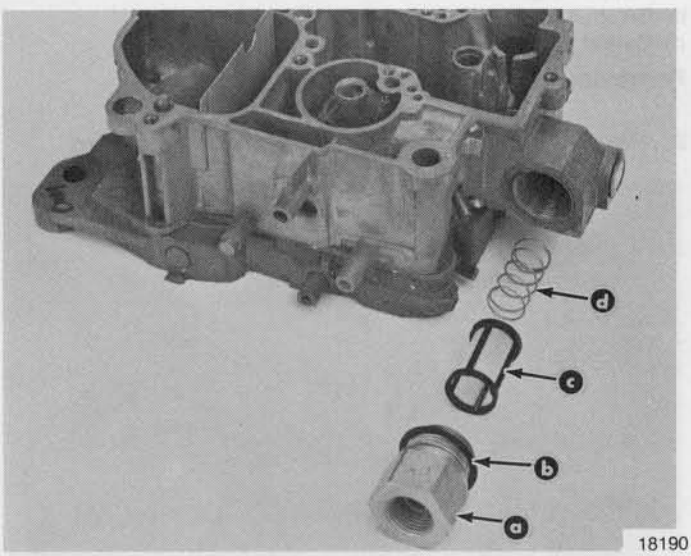


18177

a - Vacuum Control Assembly
b - Hose

Removing Vacuum Control

8. Remove fuel inlet filter nut, gaskets, filter and spring.

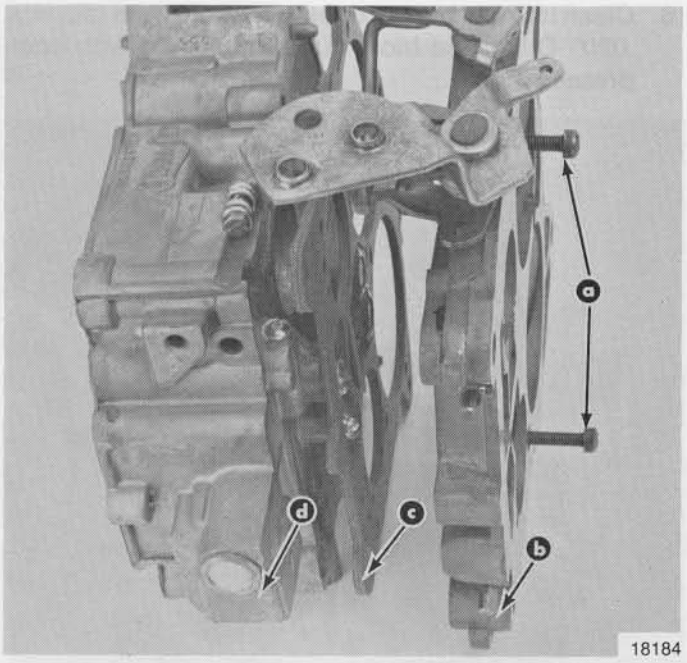


18190

a - Nut
b - Gaskets
c - Filter
d - Spring

Removing Fuel Inlet Filter Assembly

9. Separate throttle body from float bowl and remove gasket.

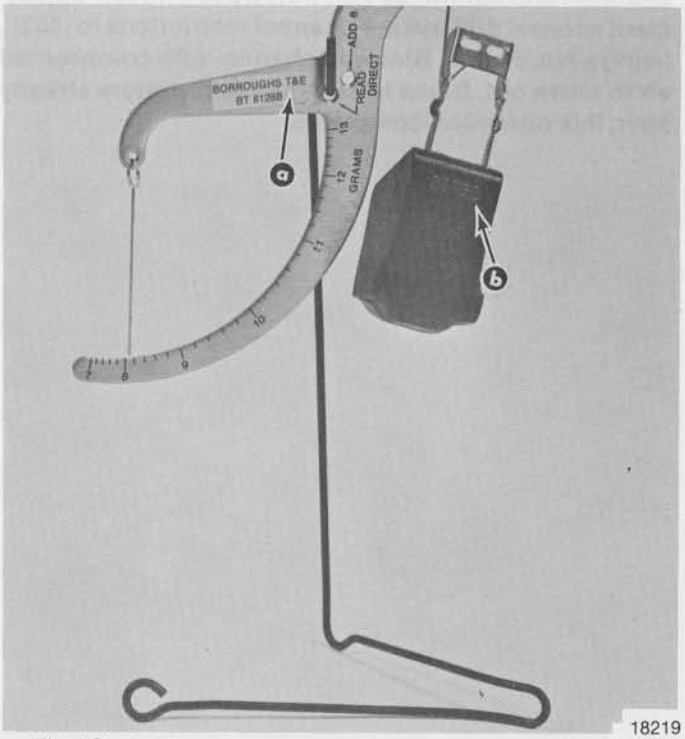


a - Attaching Screws
b - Throttle Body
c - Gasket
d - Float Bowl

Removing Throttle Body

FLOAT WEIGHT

1. Assemble float scale to instructions with scale.
2. Check float weight to specifications.



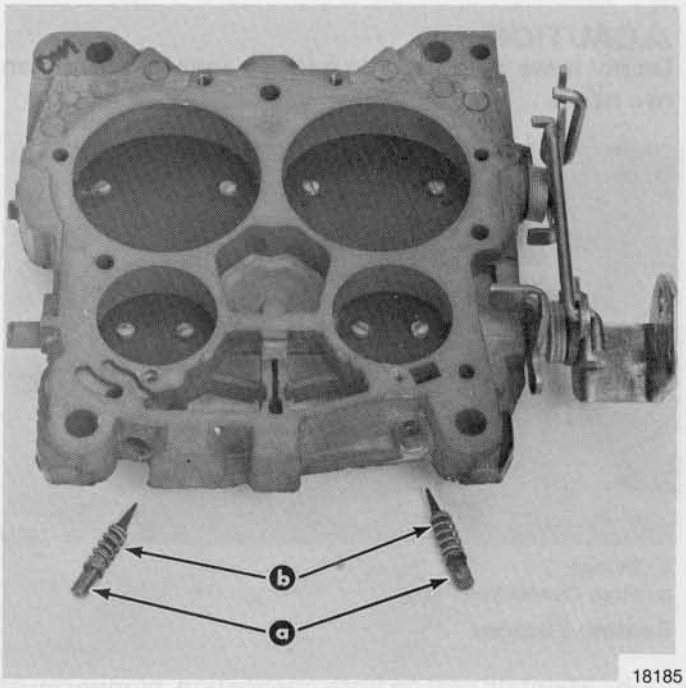
a - Float Scale
b - Float

Checking Float Weight

3. Replace float if it exceeds specifications.

THROTTLE BODY

1. Remove idle mixture screws and springs.



a - Screw
b - Spring

Removing Idle Mixture Screws

IMPORTANT: Throttle body should not be disassembled any further than shown. Throttle body is serviced as an assembly.

Cleaning and Inspection

⚠CAUTION

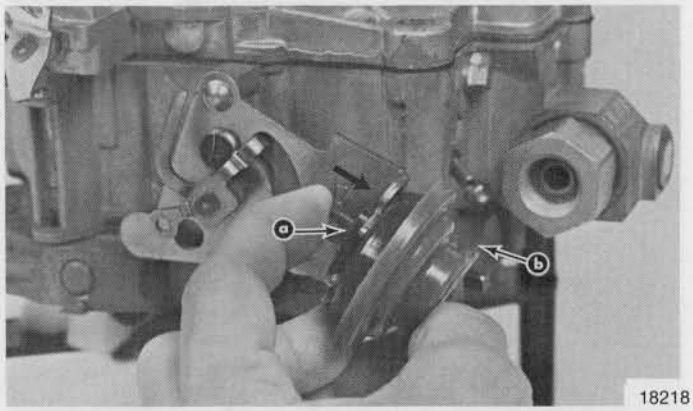
Rubber, or plastic parts, pump plungers or diaphragms cannot be immersed in carburetor cleaner. The delrin air valve cam will withstand normal carburetor cleaner.

1. Clean carburetor in immersion type cleaner.
2. Blow out passages with compressed air. Do not drill thru passages.
3. Inspect for wear:
   - Idle mixture needles
   - Float needle and seat
   - Casting surfaces
   - All levers
   - Fast idle cam
   - Power piston
   - Accelerator pump seal
4. Check all valves for binding.

5. Check vacuum break unit for leaks.

   a. Depress plunger and seal hose connection.

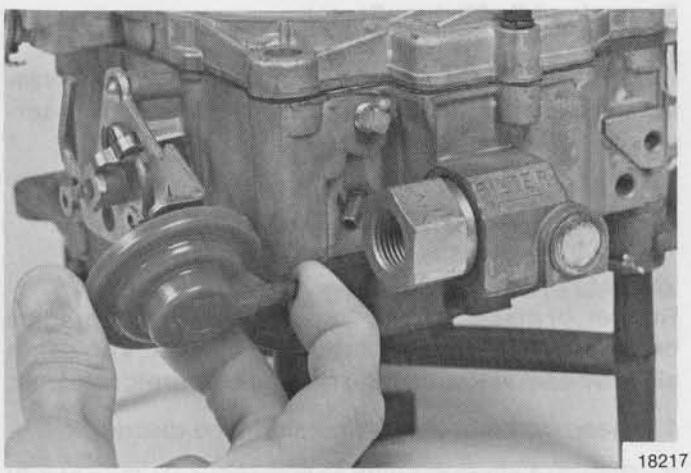
⚠CAUTION
Do not leave carburetor in carb cleaner for more than two hours.



a - Plunger
b - Hose Connection

Seating Plunger

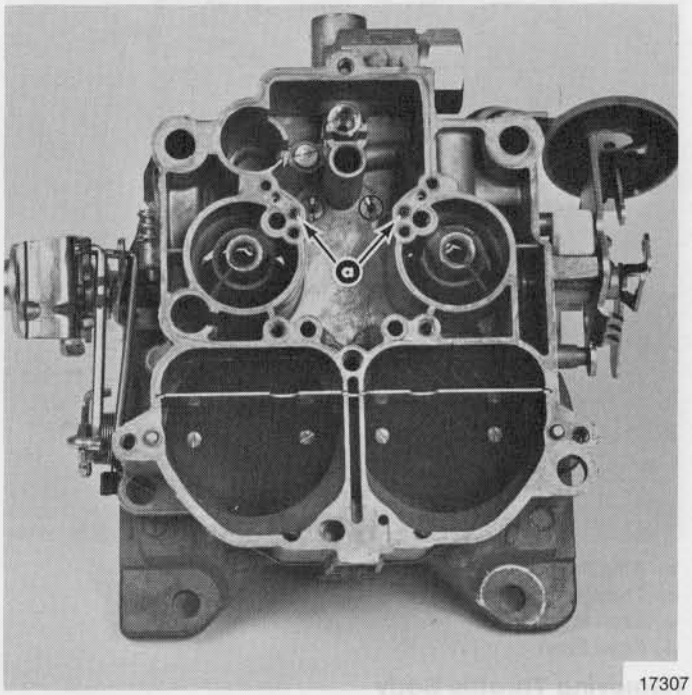
   b. Maintain seal on hose connection, plunger must remain seated. If plunger extends, replace unit.



Plunger Seated and Hose Connection Sealed

IMPORTANT: The idle fuel pickup tubes have a smaller I.D. at the bottom than the top. Do not drill.

6. Clean idle fuel pickup tubes with a fine wire (approx. .020" O.D.) and blow out all channels with compressed air.



a - Idle Fuel Pickup Tubes
b - Channel Restrictions

Cleaning Idle Passages

IMPORTANT: If engine is experiencing a rough idle situation and cannot be smoothed out with idle adjustment screws, drill out the channel restrictions to .055", using a No. 54 drill. Blow out channel with compressed air to clean out. Some later model carburetors already have this operation completed.

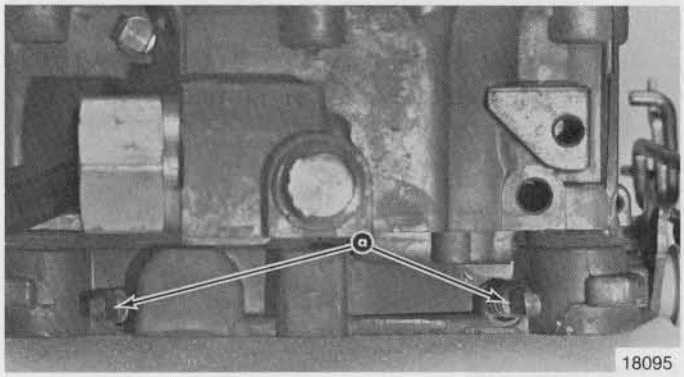
Reassembly

THROTTLE BODY

NOTICE
Refer to "Adjustments" for all adjustment procedures.

IMPORTANT: Seat idle mixture screws lightly or damage to needles and seats will result.

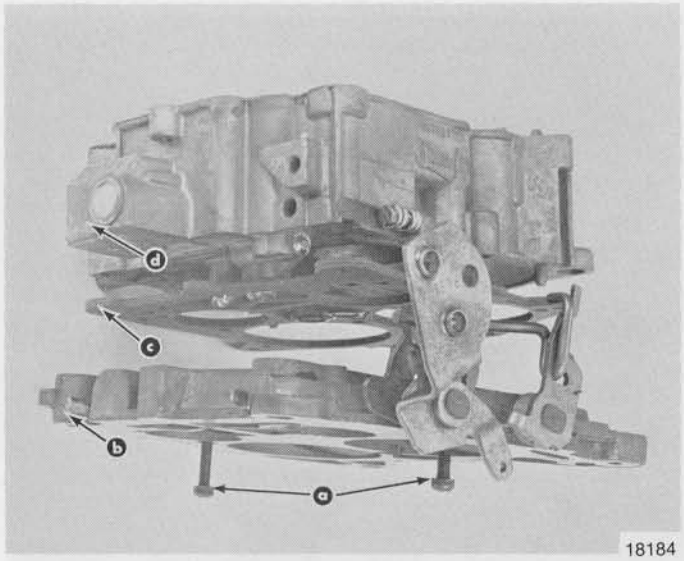
1. Install idle mixture needles and springs until lightly seated, then back out 2 to 3 turns.



a - Idle Mixture Needles and Springs

Installing Idle Mixture Needles

2. Install new gasket and assemble throttle body to float bowl. Tighten securely.



a - Attaching Screws
b - Throttle Body
c - Gasket
d - Float Bowl

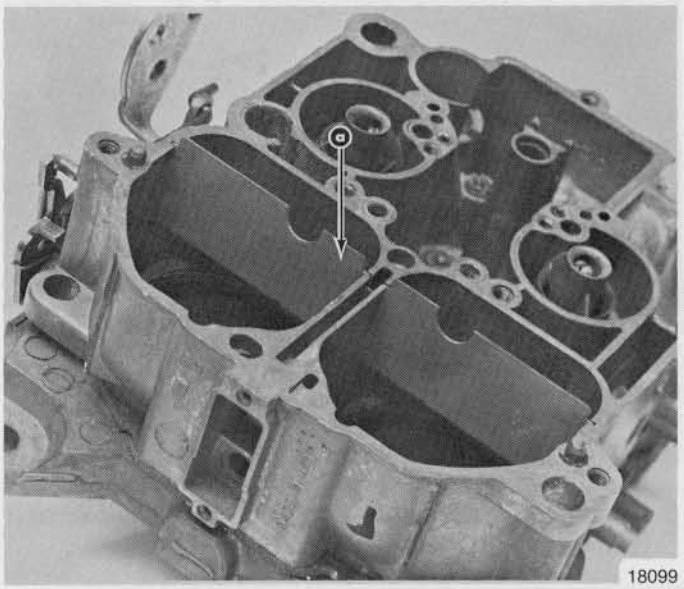
Installing Throttle Body

FLOAT BOWL

NOTICE
Refer to "Important Service Information" BEFORE proceeding.

IMPORTANT: Place carburetor on a holding fixture to prevent damage to throttle valve.

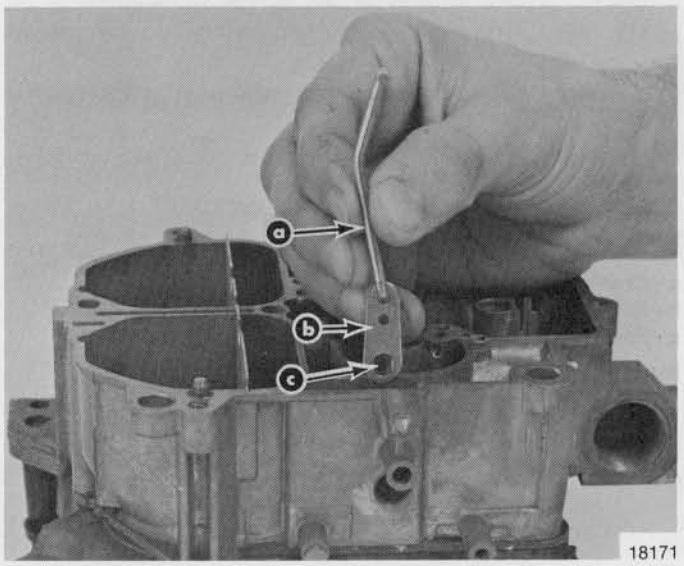
1. Install baffle plate.



a - Baffle Plate

Installing Baffle Plate

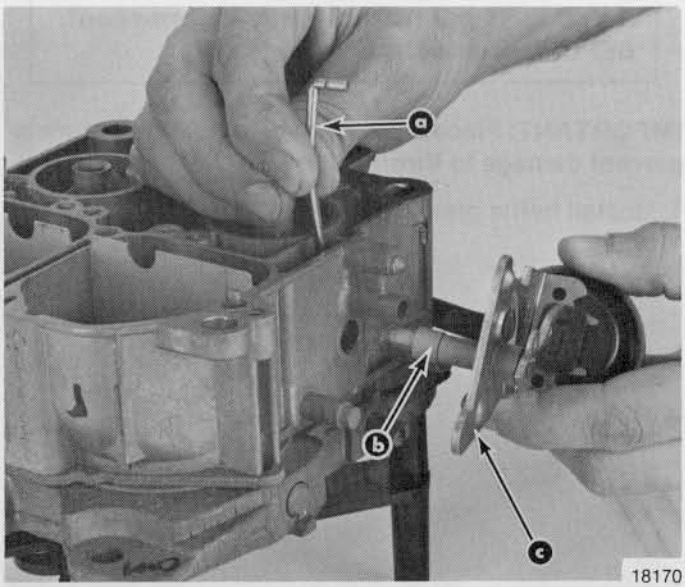
2. Install intermediate choke lever and vacuum break control bracket assembly.
   a. Using choke rod, suspend intermediate choke lever in float bowl cavity so that flat sided hole aligns with hole in side of float bowl.



a - Choke Rod
b - Choke Lever
c - Flat Sided Hole

Installing Choke Rod and Lever

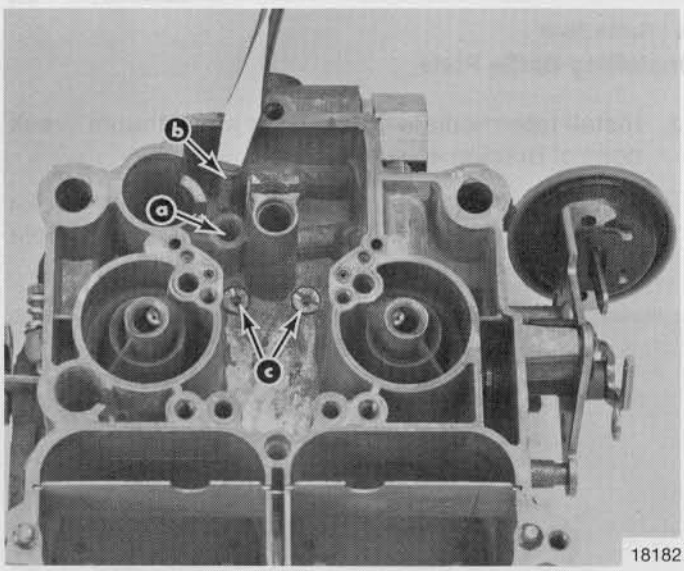
b. Insert choke shaft on vacuum break control assembly to engage flat sided hole of choke lever, and secure with screw. Tighten securely.



a - Choke Rod
b - Choke Shaft
c - Vacuum Break Control Assembly

Installing Choke Rod to Vacuum Break

3. Install pump discharge check ball, retainer and primary main metering jets. Tighten securely.

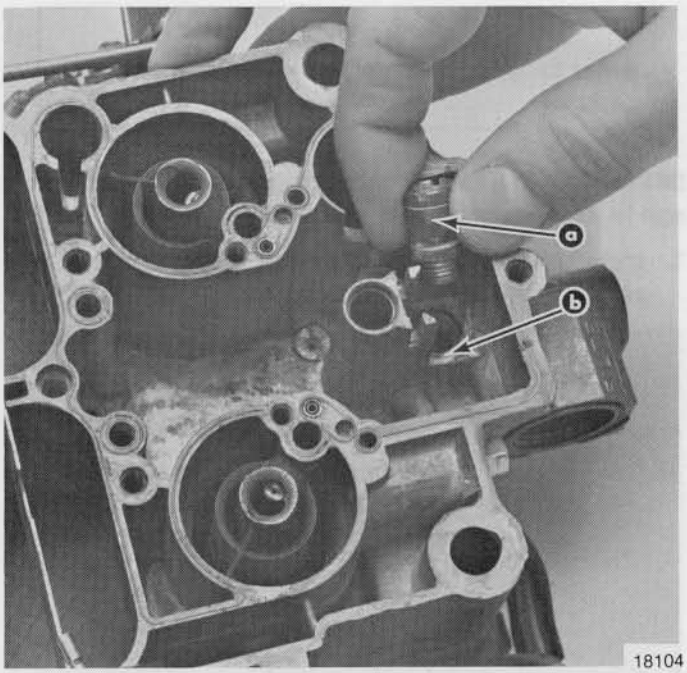


a - Check Ball (Not Shown)
b - Retainer
c - Primary Main Metering Jets

Installing Check Ball, Retainer and Primary Jets

IMPORTANT: Float needle and seat should be replaced as a set only.

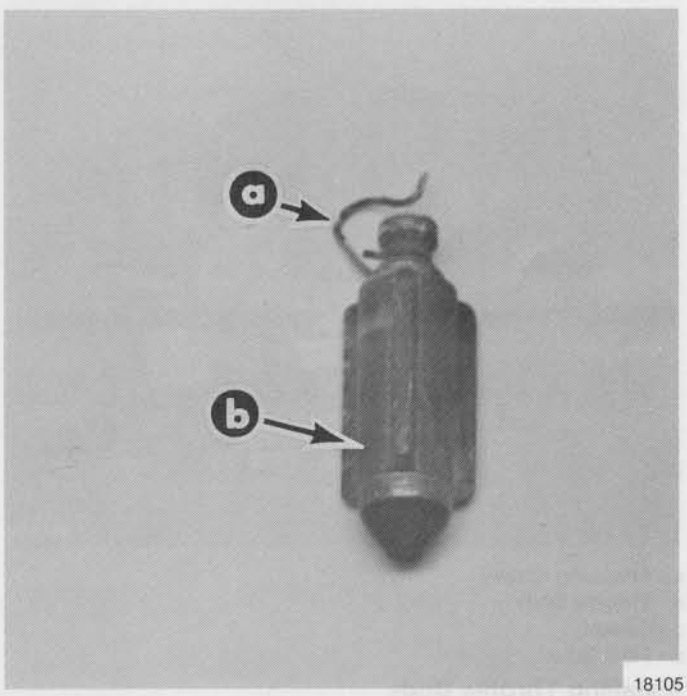
4. Install float needle seat and gasket.



a - Float Needle Seat
b - Gasket

Installing Needle Seat and Gasket

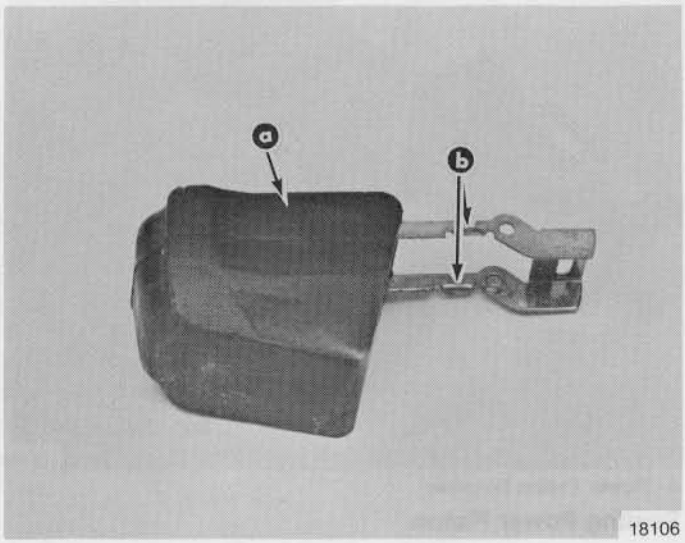
5. Installing float needle and float assembly.
   a. Install pull clip onto needle.



a - Pull Clip
b - Needle

Installing Pull Clip on Needle

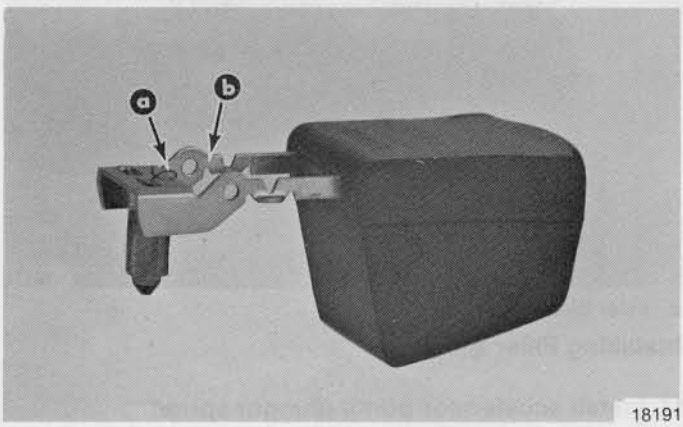
b. If a new float or needle and seat are used, bend float arm slightly upward at notch for easier adjustment.



a - Float
b - Float Arm Notch

Bending Float Arm

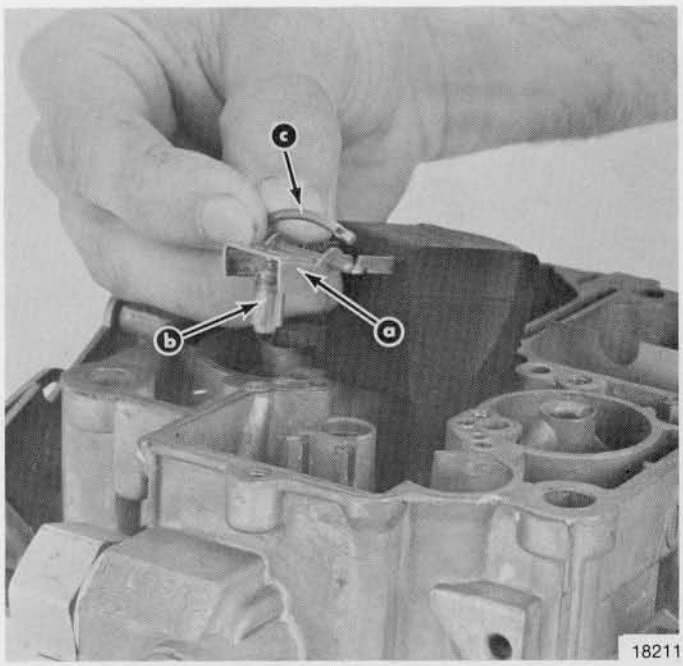
c. Hook needle pull clip over edge of float arm closest to pontoon.



a - Pull Clip
b - Float Arm

Proper Installation of Pull Clip

d. Install retaining pin into float arm and install float and needle into bowl.



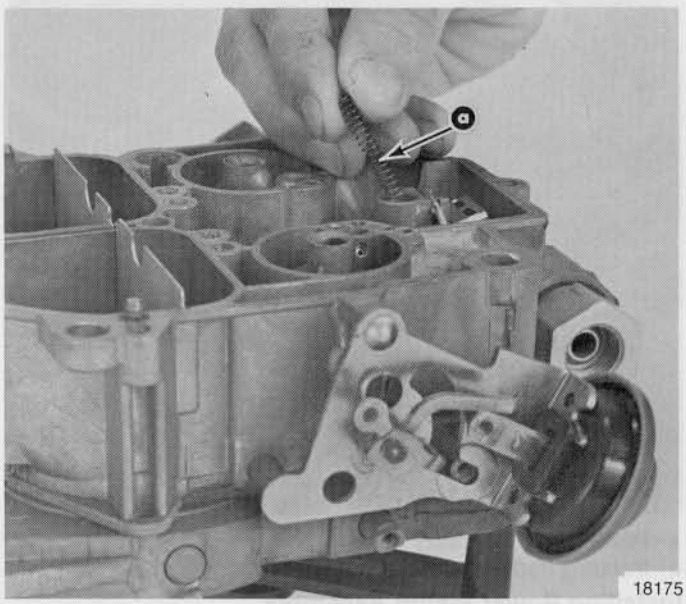
a - Float
b - Needle
c - Hinge Pin

Installing Float and Needle

IMPORTANT: Top of hinge pin must extend above casting by .010 for good pin retention.

e. Check float adjustment (refer to "Adjustment" in this section).

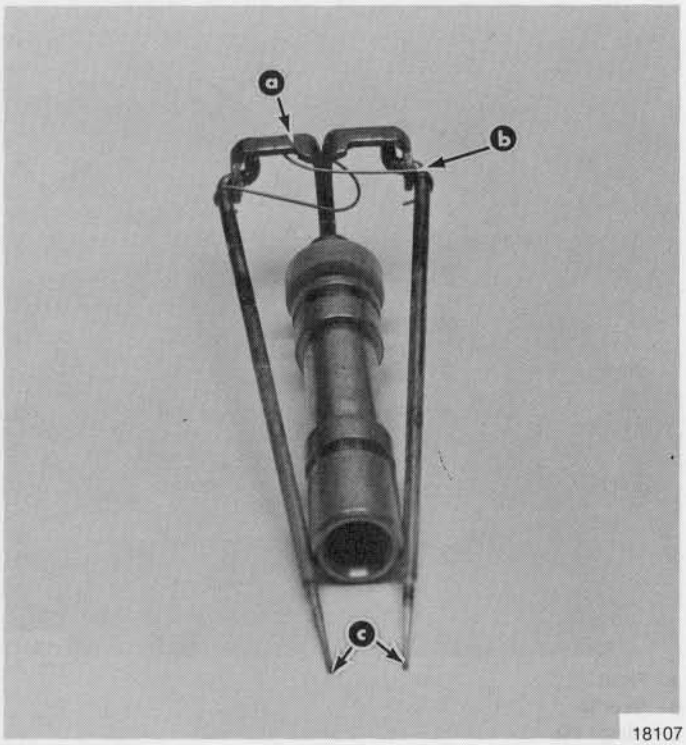
6. Install power piston spring.



a - Power Piston Spring

Installing Power Piston Spring

7. Install primary main metering rods in power piston hanger, and connect spring as shown.

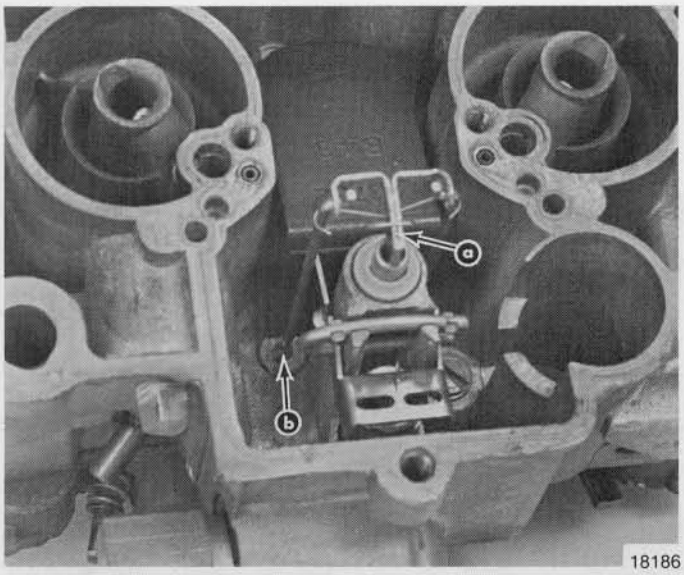


18107

a - Power Piston Hanger
b - Tension Spring
c - Metering Rods

Installing Primary Metering Rods

8. Install power piston assembly, guiding metering rod tips into main metering jets.

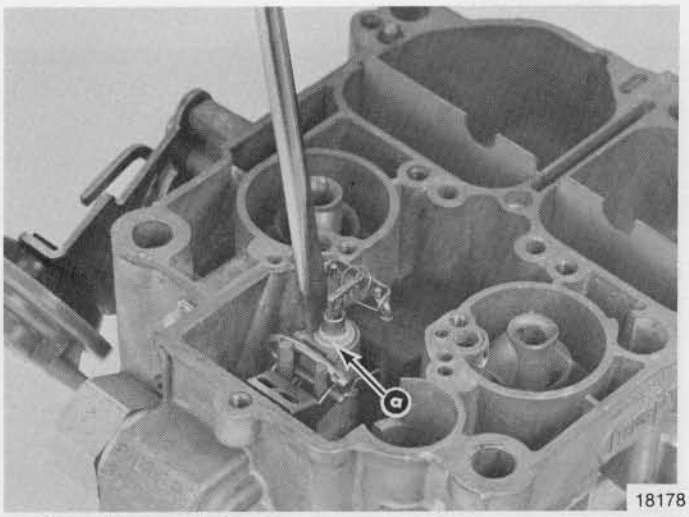


18186

a - Power Piston Assembly
b - Metering Rod Tip in Main Metering Jet

Installing Power Piston Assembly

9. Push power piston retainer down until flush with casting.

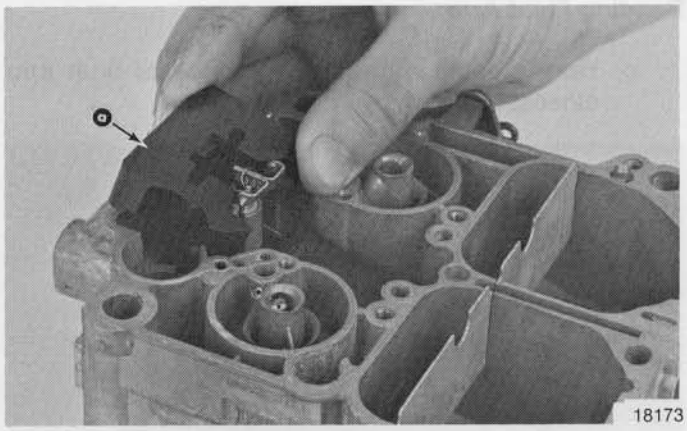


18178

a - Power Piston Retainer

Seating Power Piston

10. Install filler block.

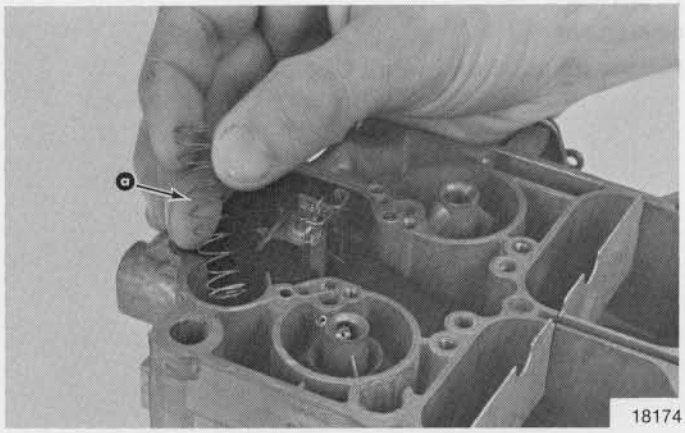


18173

a - Filler Block

Installing Filler Block

11. Install accelerator pump plunger spring.



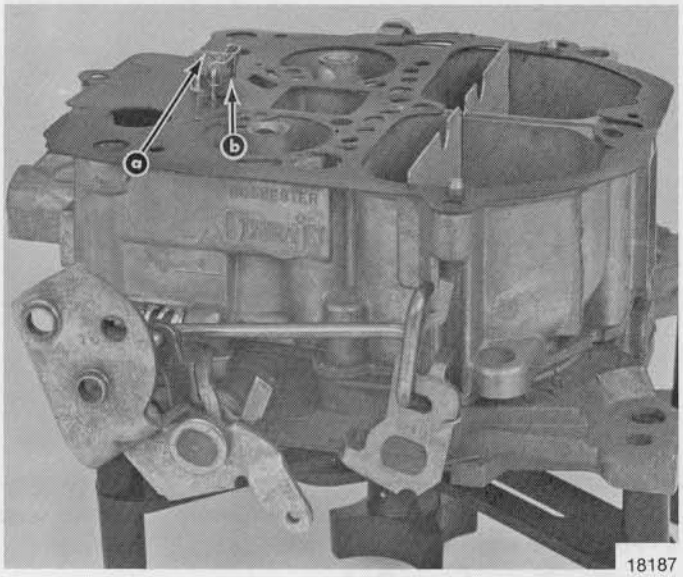
18174

a - Spring

Installing Pump Return Spring

AIR HORN

1. Install new gasket and slide tab under power piston hanger.

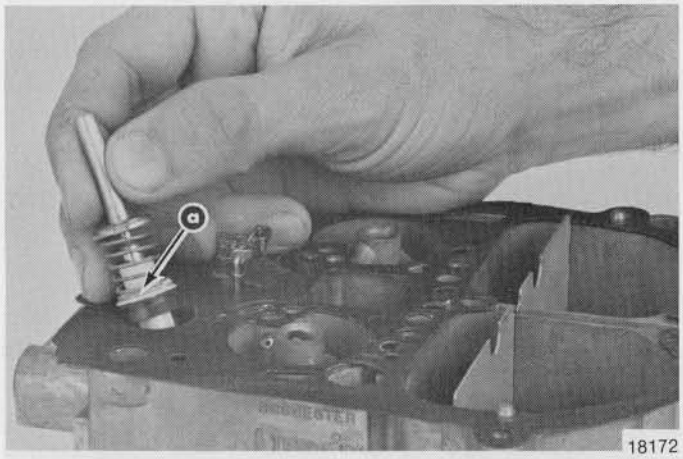


18187

a - Power Piston Hanger
b - Gasket Tab

Proper Installation of Gasket

2. Install accelerator pump plunger.

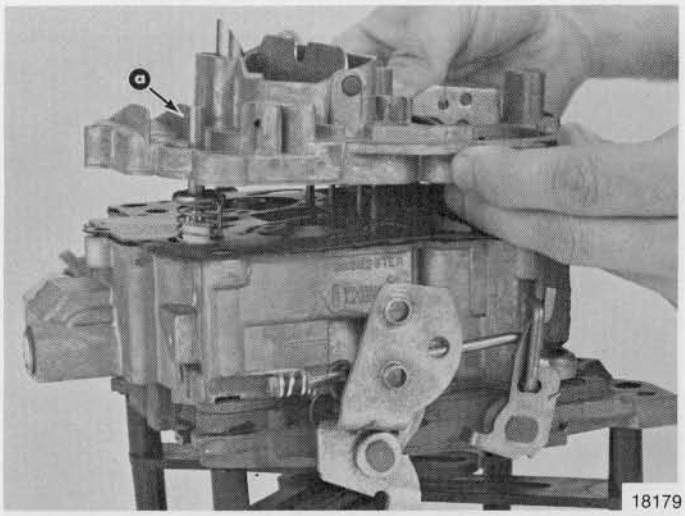


18172

a - Plunger

Installing Accelerator Pump

3. Install air horn.

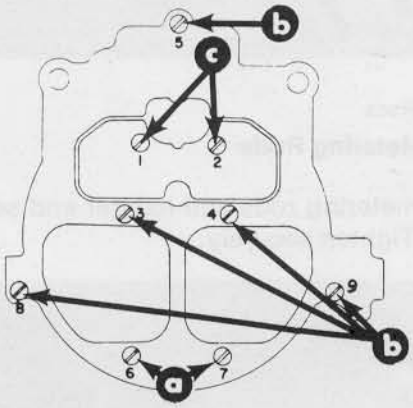


18179

a - Air Horn

Installing Air Horn

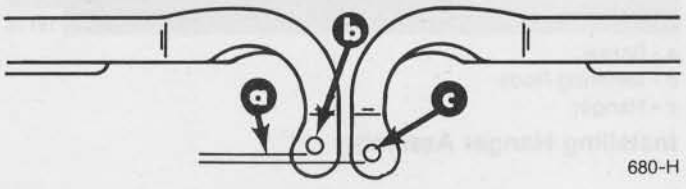
4. Install 9 attaching screws. Tighten securely in sequence as numbered.



a - Long
b - Short
c - Countersunk

Attaching Screw Installation

IMPORTANT: Hanger size may vary from specification chart. Manufacturer varies hanger size to make up differences in carburetor castings. Always install the same size hanger as was removed from the carburetor. Difference in hangers is the hole location, which affects secondary fuel metering.

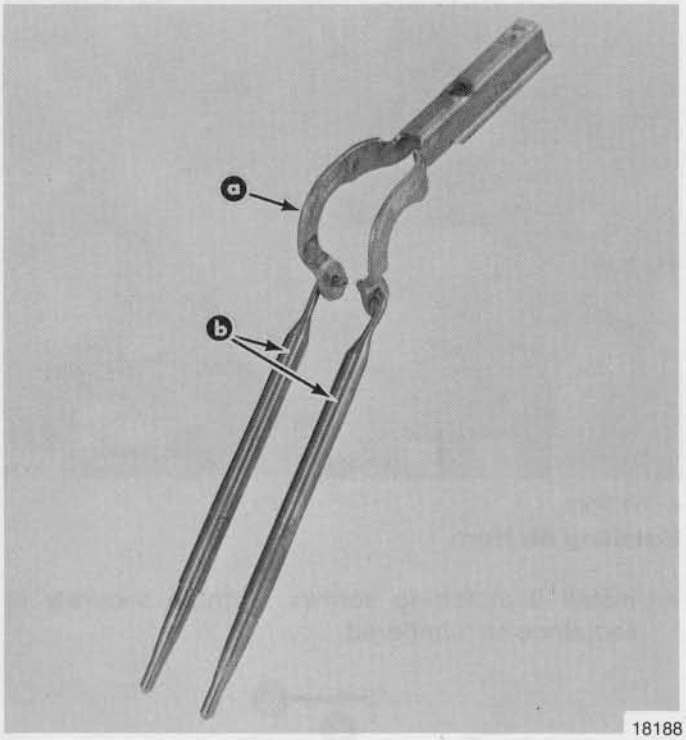


680-H

a - Hole Location Changes Fuel Metering
b - Richer
c - Leaner

Hanger Size

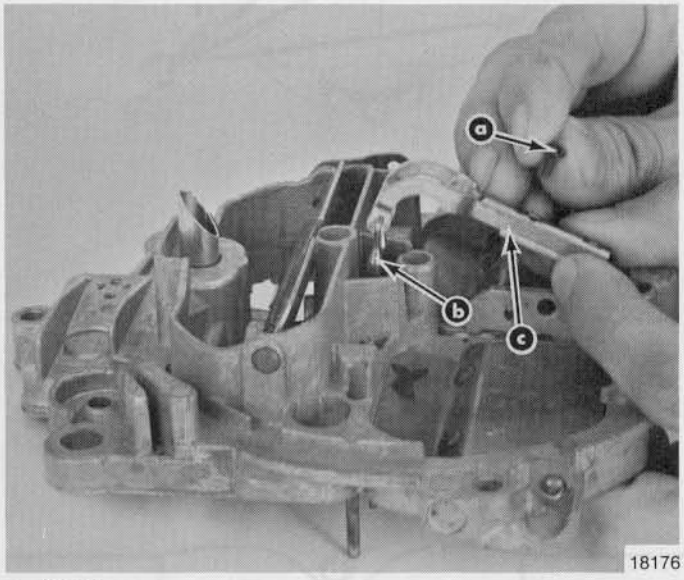
5. Install secondary metering rods into hanger with upper ends toward each other as shown.



a - Hanger
b - Metering Rods

Installing Metering Rods

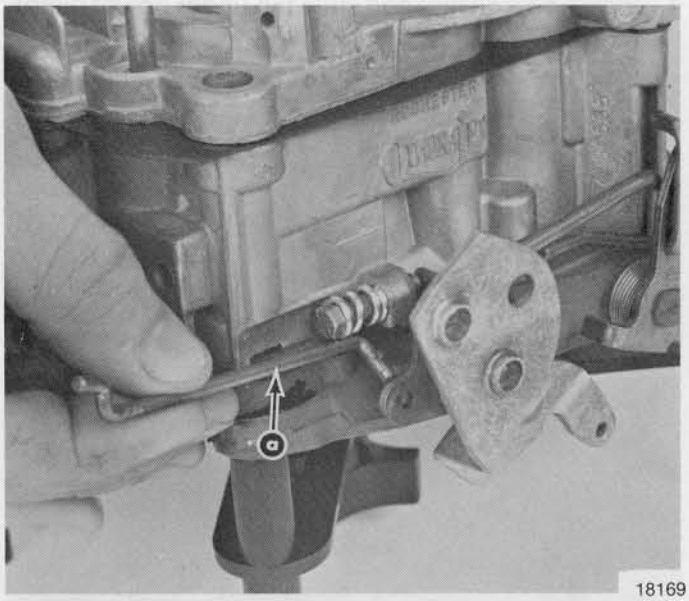
6. Install metering rods and hanger and secure with screw. Tighten securely.



a - Screw
b - Metering Rods
c - Hanger

Installing Hanger Assembly

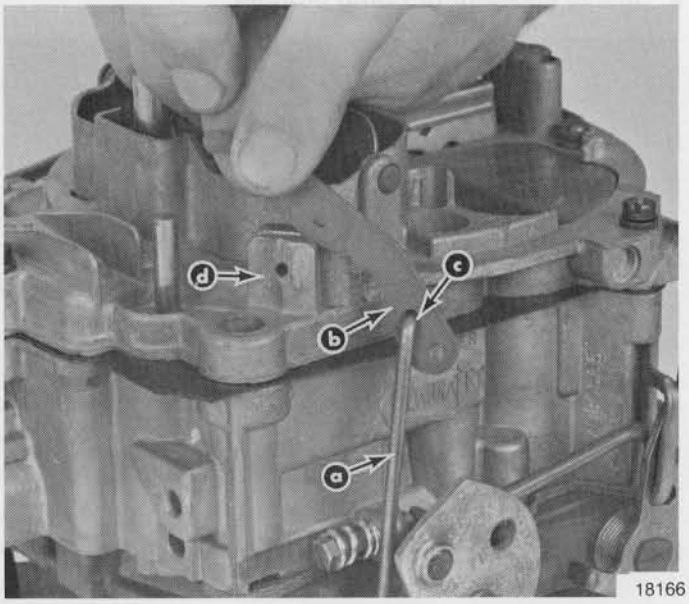
7. Install pump lever rod.



a - Pump Lever Rod

Installing Pump Lever Rod

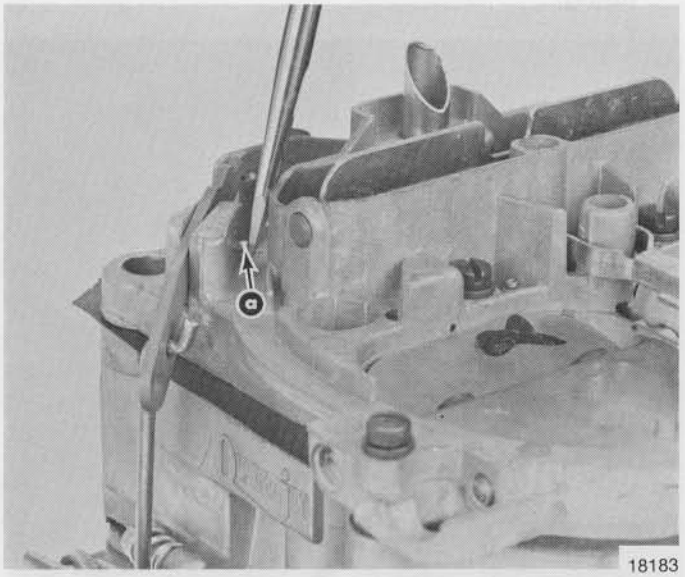
8. Install rod into lever inner hole and place lever into casting mount.



a - Rod
b - Lever
c - Inner Hole
d - Casting Mount

Locating Pump Lever Rod.

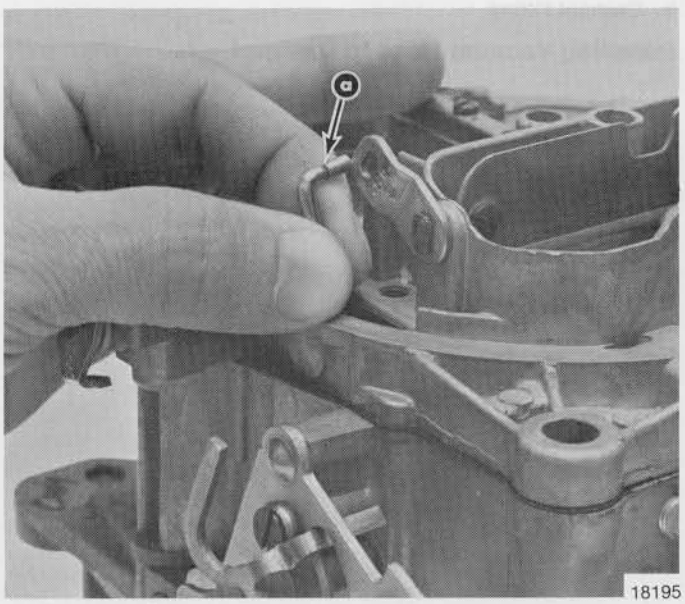
9. Press roll pin into place using a screwdriver.



a - Roll Pin

Installing Roll Pin

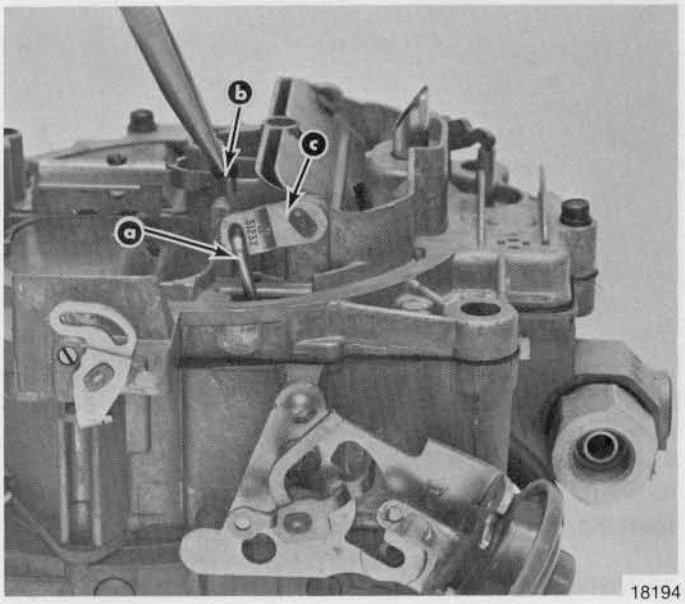
10. Install bottom end of choke shutter rod into intermediate choke lever in float bowl.



a - Choke Shutter Rod

Install Choke Shutter Rod to Intermediate Choke Lever

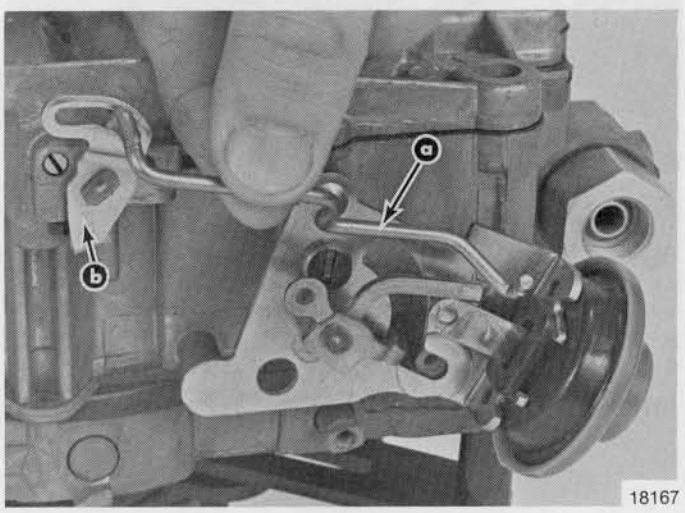
11. Install upper end of choke shutter rod into the choke blade lever, install clip onto choke shutter rod.



a - Choke Shutter Rod
b - Clip
c - Choke Blade Lever

Installing Upper End of Choke Shutter Rod

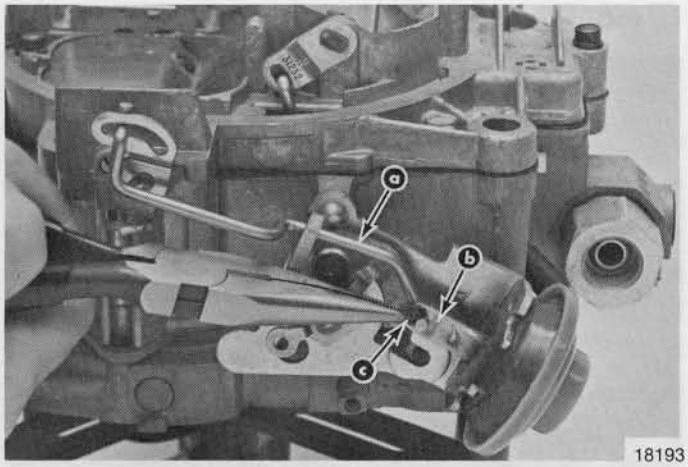
12. Install rod into air valve lever.



a - Rod
b - Air Valve Lever

Installing Air Valve Rod

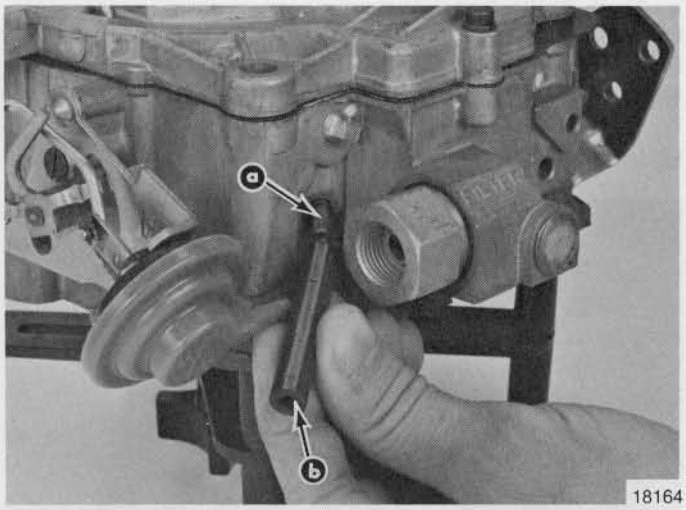
13. Install rod into vacuum break arm and install clip.



a - Rod
b - Vacuum Break Arm
c - Clip

Installing Rod to Break Arm

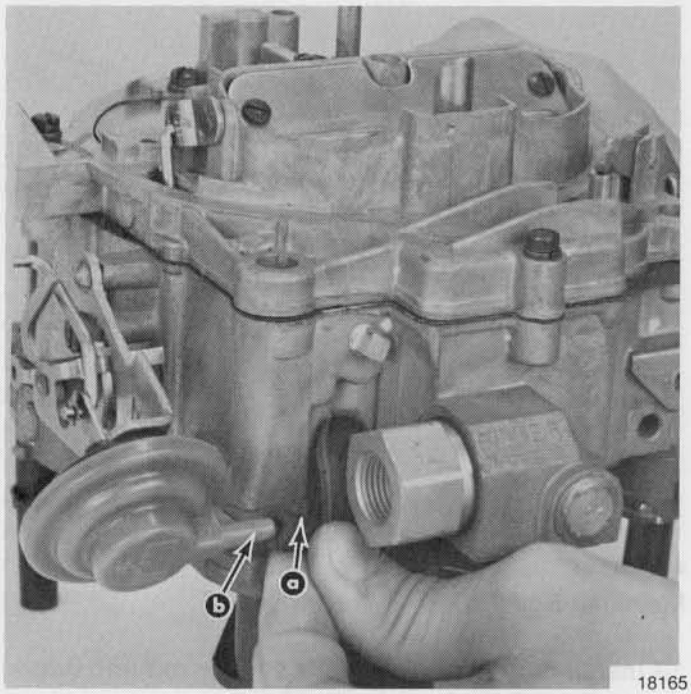
14. Install vacuum break hose onto carburetor fitting.



a - Fitting
b - Hose

Installing Vacuum Hose

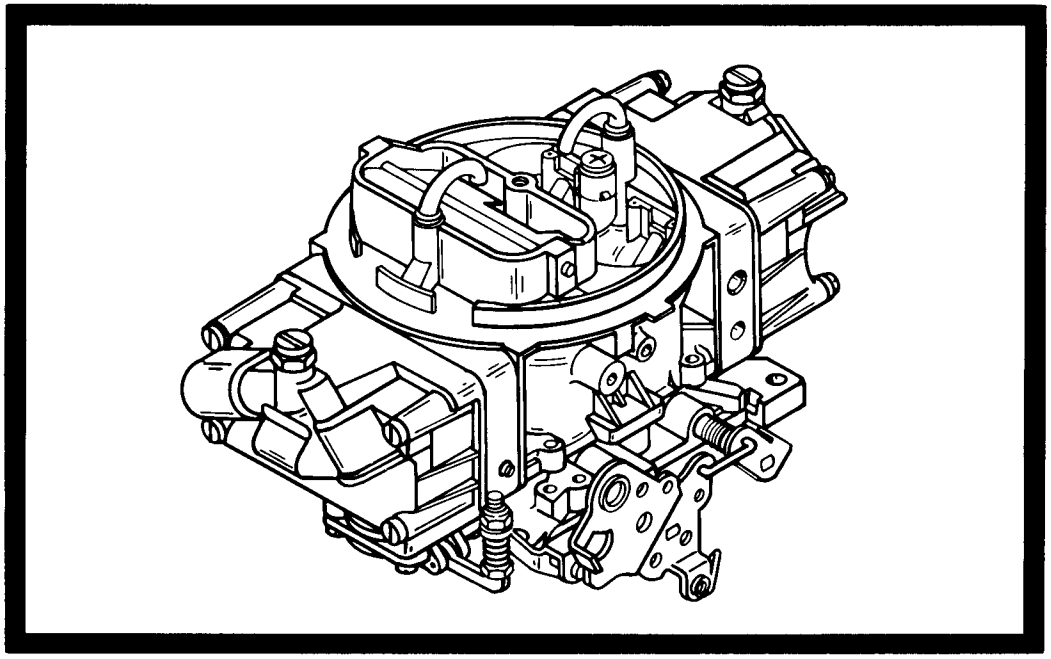
15. Install vacuum break hose onto vacuum dashpot fitting.



a - Hose
b - Dashpot Fitting

Installing Vacuum Hose to Dashpot

FUEL SYSTEM



HOLLEY 4 BARREL
Model 4150

5

D

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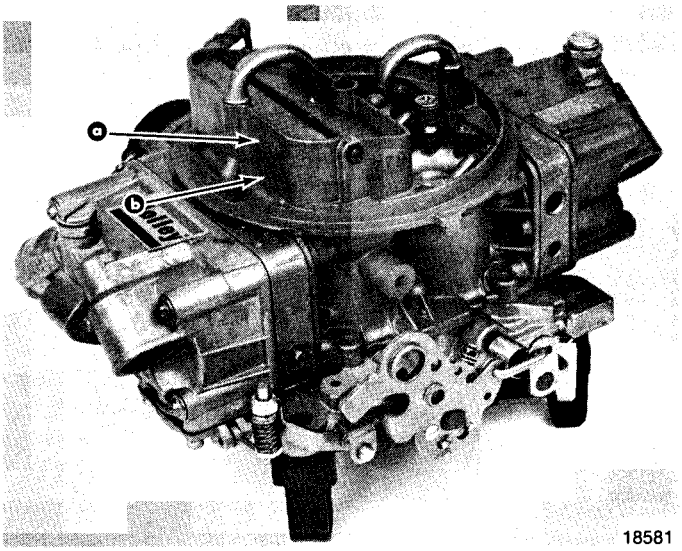
90-14499--1 887

Identification



a - Part Number
b - "MOD" (Certain Models)

Figure 1. Holley Part Number Location

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)
Carburetor to Manifold	20 (27)
Fuel Line To Carburetor	18 (24)
Fuel Inlet Filter Nut	Securely

Tools

MERCURY MARINE SPECIAL TOOLS	
91-59339	Tachometer
91-36392	Universal Carburetor Gauge

BORROUGHS TOOLS AND EQUIPMENT 2429 N. BURDICK ST. KALAMAZOO, MICHIGAN 49007 (616) 345-5163	
BT8128B	Float Gram Scale

Specifications

Engine Model	MCM 420 440/460 Cyclone
Make	Holley
Model	4150
Holley Part No.	4781
Mercury Part No.	1393-8862
Main Primary Jets	.084
Main Secondary Jets	.084
Accelerator Pump	.015 (.4mm)
Accelerator Pump Check Ball	.015" (4mm)
Float Adjustment	Bottom of Sight Plug Hole ±1/32" (.8mm)
Float Weight	15.6 Grams Max.
Choke Setting	Index Marks Aligned
Preliminary Idle Mixture Setting	2 Turns

Description

The model 4150 is a 4 bore Holley carburetor with an electrically operated automatic choke. The Holley model 4150 is a dual feed, double pump carburetor. This means each fuel bowl has a seperate fuel inlet and there 2 accelerator pumps, one for the primary side and one for the secondary side. Between the fuel bowls and the carburetor body, metering bodies are located. The metering bodies contain the main jets, power valve, and the majority of the metered passages in the carburetor. Both the primary and secondary floats have an external float adjustment.

Precautions

⚠WARNING
Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING
Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key "OFF". Do not smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING
Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". Do not smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING
Make sure no fuel leaks exist, before closing engine hatch.

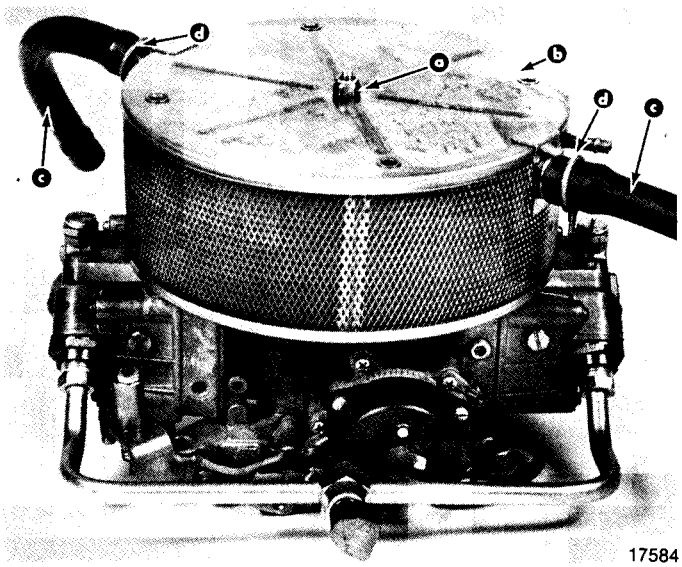
⚠CAUTION
Do not operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Maintenance

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

Flame Arrestor

1. Remove (in the following order):
   a. Nut.
   b. Washer (Not Shown).
   c. Hose clamps and crankcase ventilation hoses - From flame arrestor and rocker arm covers.
   d. Flame arrestor - Lift from carburetor.
2. Clean and Inspect:
   a. Clean flame arrestor by blowing it out with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hose for cracks or deterioration, replace if neccessry.
3. Install (in the following order):
   a. Flame arrestor - Place on carburetor.
   b. Crankcase ventilation hoses and clamps - To flame arrestor and rocker arm covers.
   c. Washer (Not Shown).
   d. Nut - Tighten securely, do not overtighten.



17584

a - Nut
b - Flame Arrestor
c - Crankcase Ventilation Hoses
f - Clamps

Flame Arrestor

Fuel Filters

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

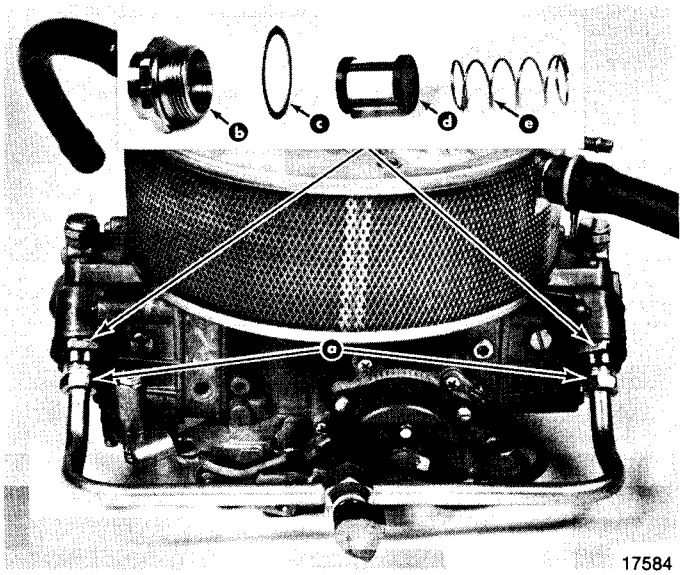
Carburetor inlet filters are located in float chamber assemblies behind fuel inlet fittings. To replace filters proceed as follows:

1. Remove fuel line from fuel inlet filter nuts.
2. Remove fuel inlet filter nut, gasket, filter and spring from each float chamber assembly. (Discard gasket and filter).
3. Clean nuts and springs in solvent and dry with compressed air.
4. Install spring, new filter (with open end outward), gasket and fuel inlet filter nut into each float chamber assembly (in that order). Tighten nut securely.
5. Reconnect fuel line and tighten securely.
6. Run engine and check for gasoline leaks.

Choke Inspection

The choke does not require any periodic maintenance; however, if a choke malfunction is suspected, the following should be done:

1. With engine off, remove flame arrestor.
2. Open and close choke several times, and check for binding, loose or disconnected linkages, or other signs of damage.
3. If choke or linkage binds, sticks, or works sluggishly, clean with carburetor choke cleaner. Carefully follow directions on can.



17584

a - Fuel Line Fittings
b - Fuel Filter Nut
c - Filter Nut Gasket
d - Filter
e - Spring

Fuel Inlet Filter

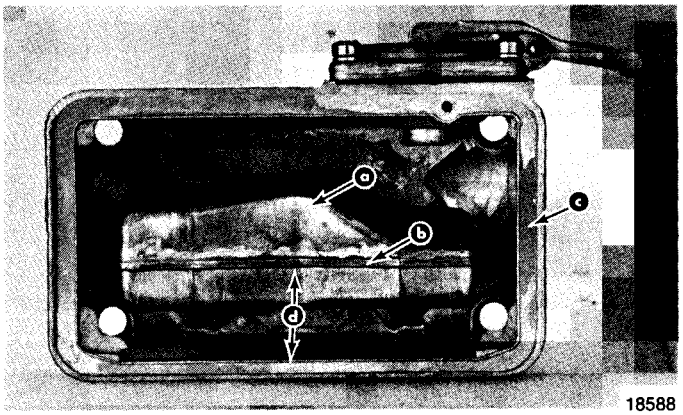
Adjustments

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

Preliminary Float Adjustment

IMPORTANT: The preliminary float adjustment will provide a sufficient setting for starting the engine. Final float adjustments must be made with engine running.

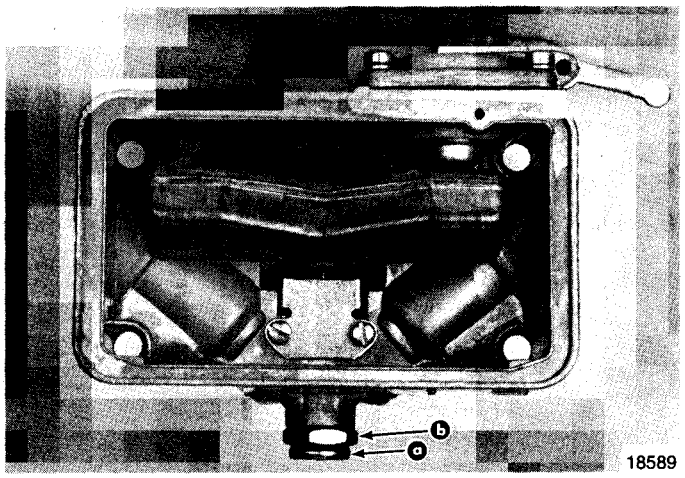
1. Invert float bowl as shown.
2. Loosen locking screw and turn float adjustment nut to adjust float.
3. Proper float adjustment is achieved when parting line on float is parallel with fuel bowl. Parting line must be parallel all the way around float.



18588

a - Float
b - Float Parting Line
c - Fuel Bowl (Inverted)
d - Parallel All The Way Around Float

Preliminary Float Setting



18589

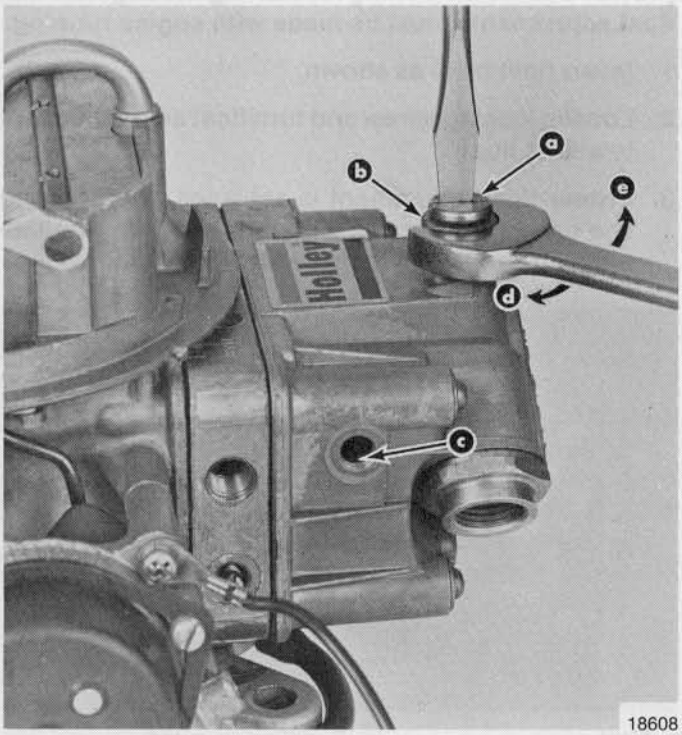
a - Locking Screw
b - Adjustment Nut

Adjusting Float Level

4. Repeat this procedure for both floats.

Final Float Adjustment

1. With carburetor mounted on engine, start engine and leave run for several minutes.
2. While engine is running remove sight plug on primary fuel bowl.
3. Loosen locking screw and turn adjustment nut slowly until fuel can be seen even with the bottom of the sight plug hole.



18608

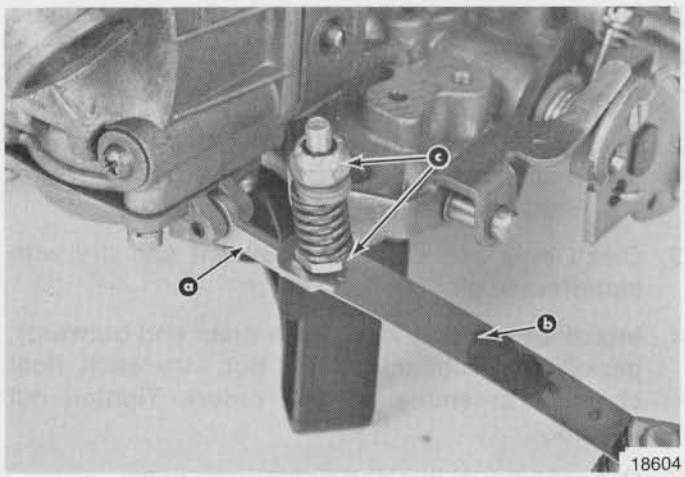
a - Locking Screw
b - Adjustment Nut
c - Sight Plug Hole
d - Raises Fuel Level
e - Lowers Fuel Level

Final Float Adjustment

4. Tighten locking screw securely being careful not to let adjustment nut turn.
5. Reinstall sight plug and gasket.
6. Repeat this procedure for secondary side of carburetor.

Accelerator Pump

1. With engine shut off, move throttle arm to W.O.T. position.
2. While holding throttle arm in W.O.T. position push down on primary accelerator pump lever.

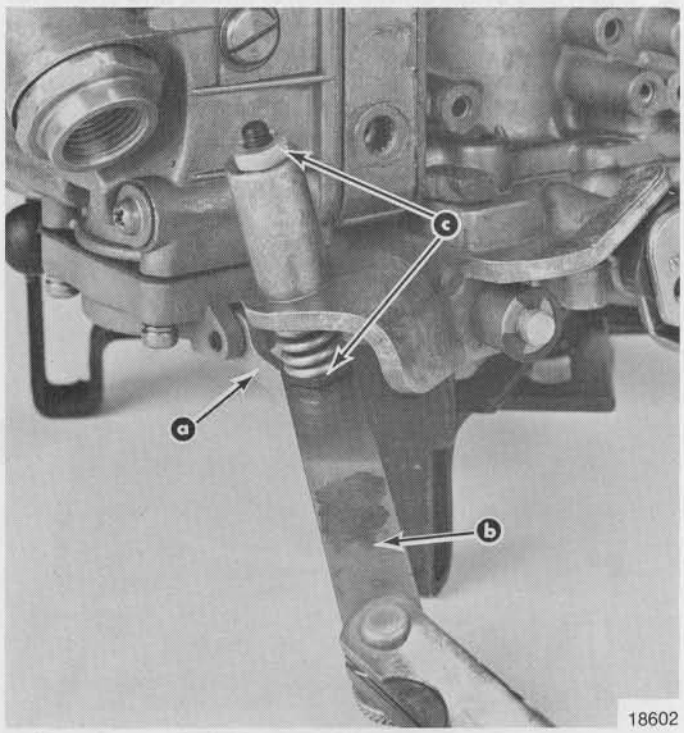


18604

a - Pump Lever - Push Down
b - Feeler Gauge
c - Adjustment Screw and Nut

Primary Accelerator Pump Adjustment

3. With a feeler gauge check for clearance between adjustment screw and accelerator pump lever. Adjust screw and nut to specifications.
4. Repeat procedure for secondary accelerator pump.



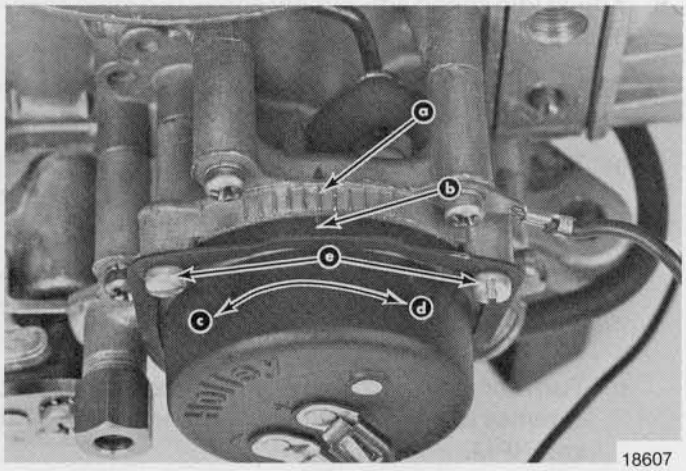
18602

a - Pump Lever - Push Down
b - Feeler Gauge
c - Adjustment Screw and Nut

Secondary Accelerator Pump Adjustment

Choke Adjustment

1. Normal choke setting is such that scribed mark on choke cover is in line with center mark on choke housing.



a - Choke Housing Mark
b - Choke Cover Mark
c - Richer Adjustment
d - Leaner Adjustment
e - Cover Retaining Screws (One Not Shown)

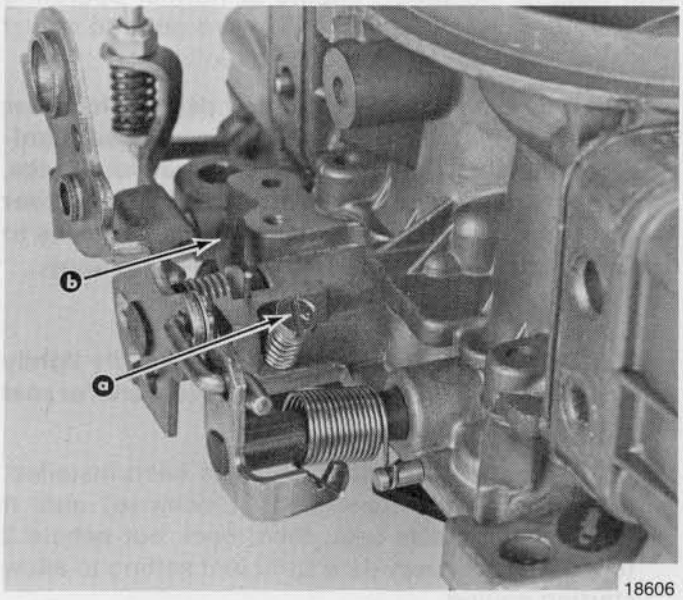
Choke Adjustment

2. If choke adjustment is necessary:
   a. Loosen 3 choke cover retaining screws and adjust as shown.
   b. Tighten 3 choke cover retaining screws securely.

Preliminary Idle Speed and Mixture

IMPORTANT: The following adjustments will provide a sufficient setting to start engine. Final adjustments must be made with engine running.

1. Turn idle speed screw in until it just contacts idle stop, then turn screw in one additional turn.

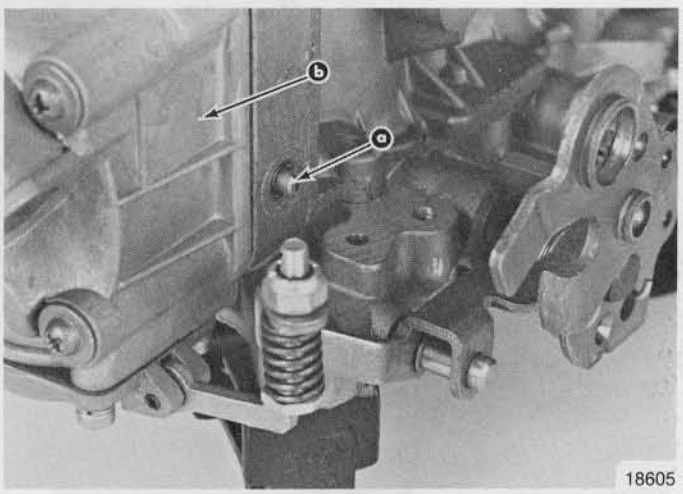


a - Idle Speed Screw

Idle Speed Screw

IMPORTANT: Do not turn idle mixture needles tightly against seat (in the following step), as damage to seat and/or needle may result.

2. Turn idle mixture needles in until they LIGHTLY SEAT; then back out 2 turns.



a - 2 Idle Mixture Screws - Only One Shown
b - Primary Fuel Bowl

Idle Mixture Screws

Final Idle Speed and Mixture

IMPORTANT: Boat must be in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles smoothly within range given under "Specifications", following, with boat in the water, engine at normal operating temperature and drive unit in forward gear. to adjust idle speed and mixture, proceed as follows:

IMPORTANT: Do not attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

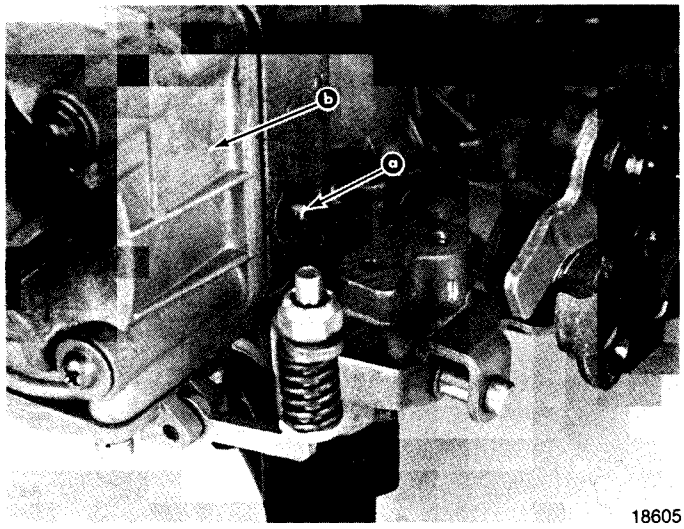
1. Connect a shop tachometer to engine.

IMPORTANT: Do not turn idle mixture needle tightly into set (in next step), as damage to needle and/or seat may result.

2. If a new or rebuilt carburetor has been installed, turn idle mixture needles in (clockwise) until it LIGHTLY contacts seat; then, back out needle 2 turns. This will provide a sufficient setting to allow starting engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠WARNING

Do not leave the helm unoccupied while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.



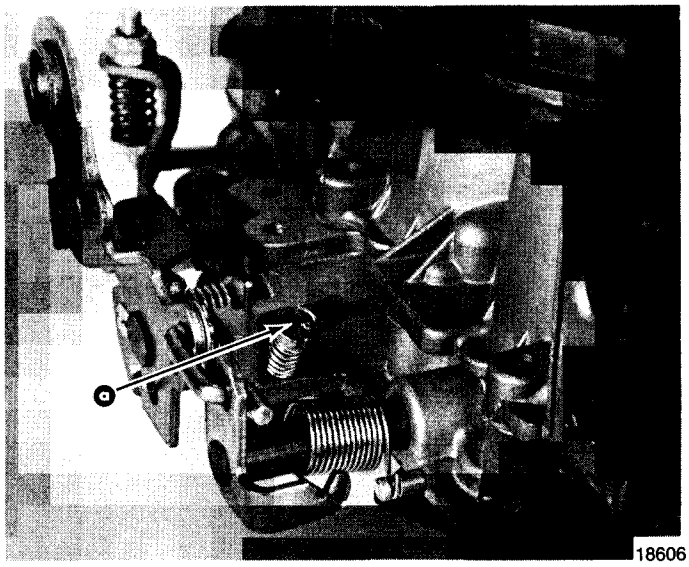
18605

a - 2 Idle Mixture Scews - Only One Shown
b - Primary Fuel Bowl

Idle Mixture Adjustment

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable brass barrel from anchor stud.
6. Adjust idle speed adjustment screw to obtain specified RPM.
7. With engine running at specified RPM, adjust mixture needle, as follows:
   a. Turn idle mixture needle inward (clockwise) until the engine speed begins to drop due to lean mixture.
   b. Turn idle mixture screw outward (counterclockwise) until the speed begins to drop due to lean mixture.
   c. Turn screw inward to a point between these two extemes to obtain maximum engine smoothness and RPM.
   d. Repeat procedure with other needle.
   e. Readjust idle speed adjustment screw, if necessary, to obtain specified RPM.

IMPORTANT: Refer to "Section 2, Part H" for throttle cable installation and adjustment.



18606

a - Idle Speed Screw

Idle Speed Adjustment

Repair

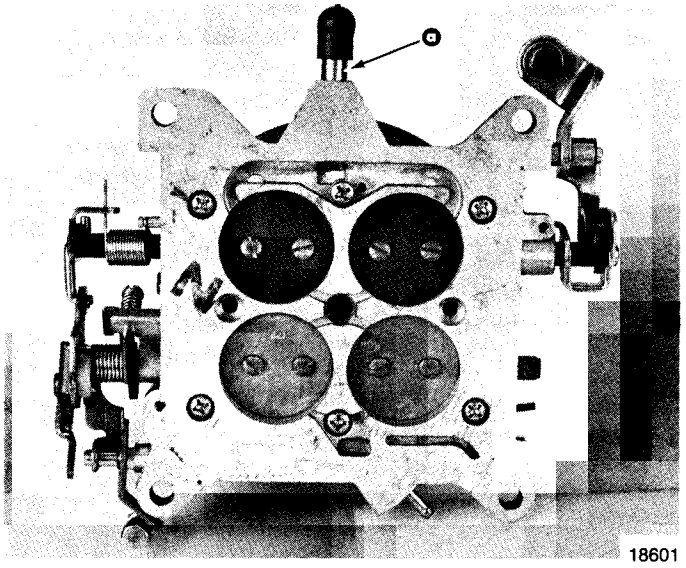
NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

Modifications

IMPORTANT: There may be several modifications made to the Holley carburetor. The carburetor will have "MOD" etched into casting at location shown in "Identification" photo.

THROTTLE BODY

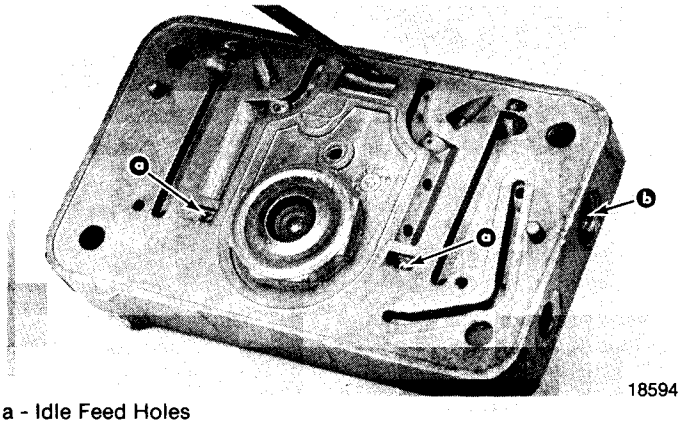
1. Vacuum tube is removed and a 1/8" NPT pipe plug is installed.



a - Vacuum Tube is Removed

PRIMARY METERING BODY

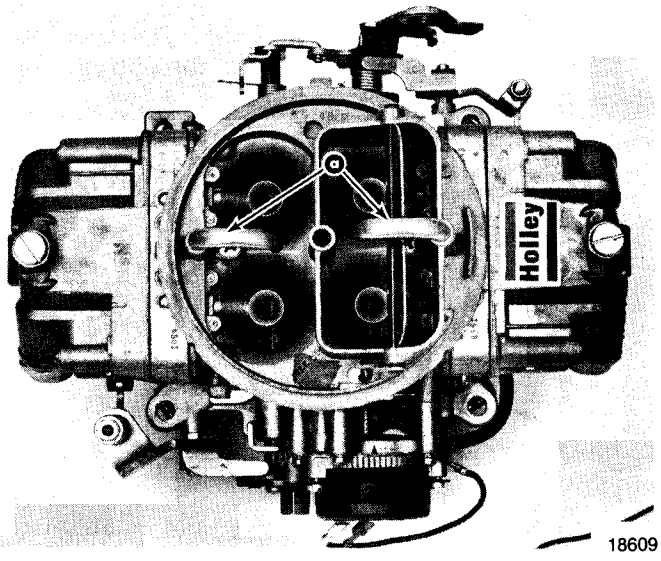
1. The idle feed holes are drilled to .040".
2. A 1/8" NPT pipe plug is installed in the vacuum hole.
3. .084" jets are installed in both the primary and secondary metering blocks.



a - Idle Feed Holes
b - Plug Installed in This Hole

CARBURETOR BODY

1. The original bowl vents are removed, the holes are drilled to .316" and new "J" tube vents are installed.



a - New "J" Tube Bowl Vents

Removal

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may, then, be inspected for contamination as carburetor is disassembled.

1. Remove crankcase ventilation hoses from flame arrestor; then, remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and and foreign material from falling into bores.

2. Turn fuel supply off at fuel tank.
3. Disconnect throttle cable from carburetor.
4. Remove fuel lines. Refer to "Fuel Inlet Filter".
5. Remove fuel pump sight tube.
6. Disconnect electric choke.
7. Remove carburetor attaching nuts and washers and remove carburetor.
8. Remove and discard gaskets.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

Installation

1. Thoroughly clean gasket surfaces. Use care to prevent gasket material from entering intake manifold.
2. Place new carburetor base gasket on intake manifold. Install carburetor and secure with nuts and washers. Torque to specifications.
3. Connect fuel lines to fuel inlet nuts and torque to specifications.
4. Connect fuel pump sight tube.
5. Connect electric choke wires to choke cover.
6. Move throttle lever back-and-forth and check for binding in throttle linkage.
7. Install throttle cable, as explained, in "Section 2.
8. Install flame arrestor and crankcase ventilation hoses.
9. Reconnect battery cables to battery.
10. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
11. Adjust idle speed and idle mixture, as outlined under "Adjustments", preceding.

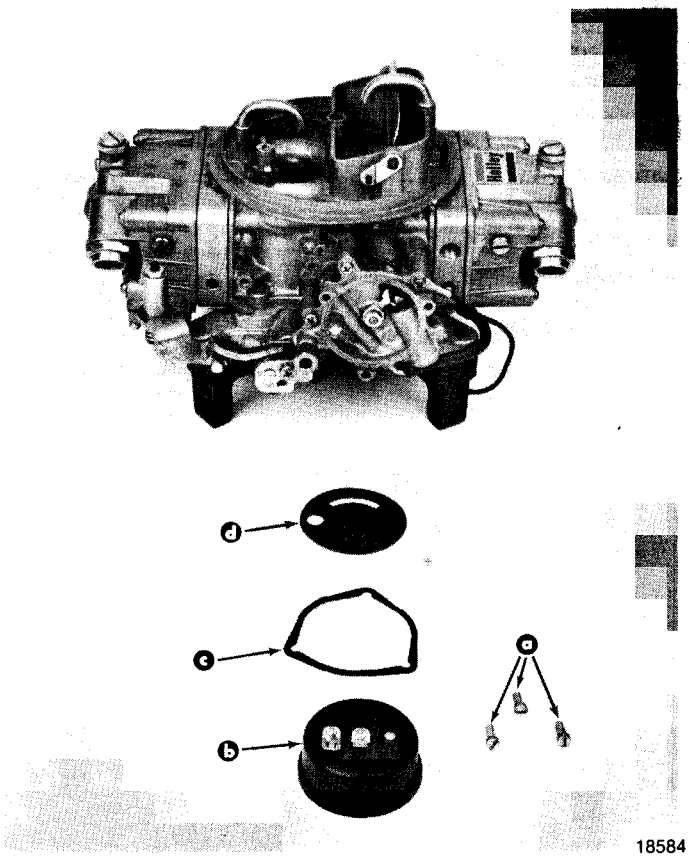
Disassembly

The following is a step-by-step procedure for completely overhauling carburetor removed from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing any unnecessary steps.

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

CHOKE HOUSING

1. Remove choke cover.

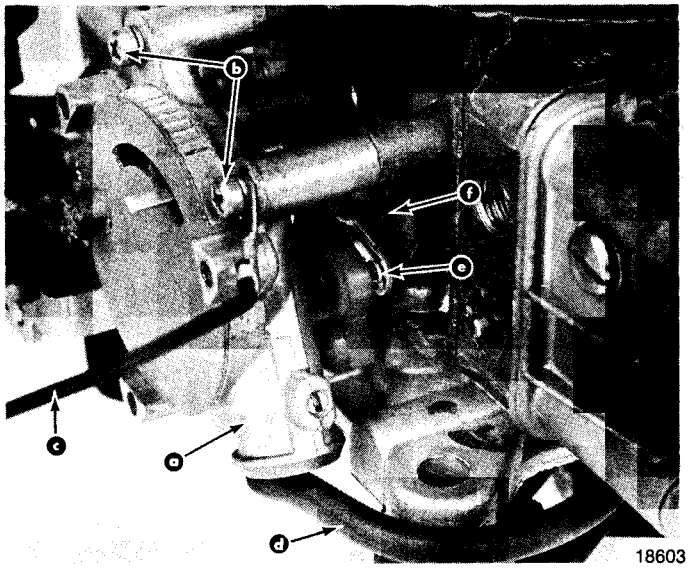


18584

a - Choke Cover Retaining Screws
b - Choke Cover
c - Choke Cover Retainer
d - Gasket

Removing Choke Cover

2. Remove choke rod retaining clip.

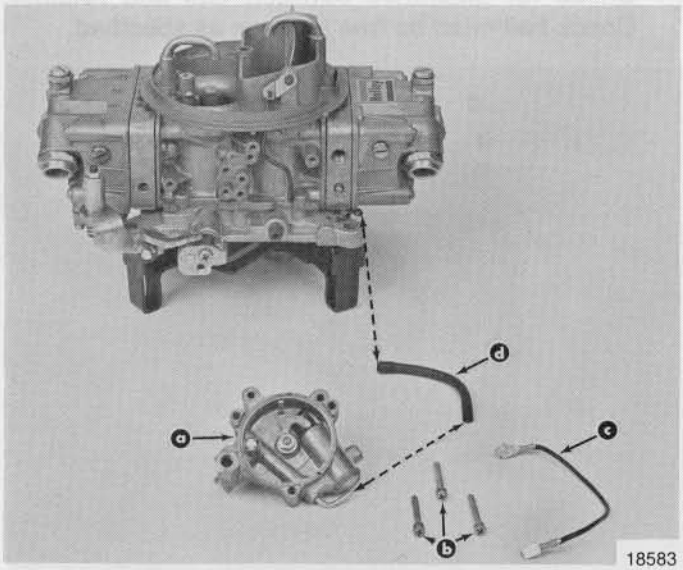


18603

a - Choke Housing
b - Housing Retaining Screws
c - Ground Wire
d - Vacuum Hose
e - Choke Rod Retaining Clip
f - Choke Rod

Removing Choke Rod Retaining Clip

3. Remove choke housing.



18583

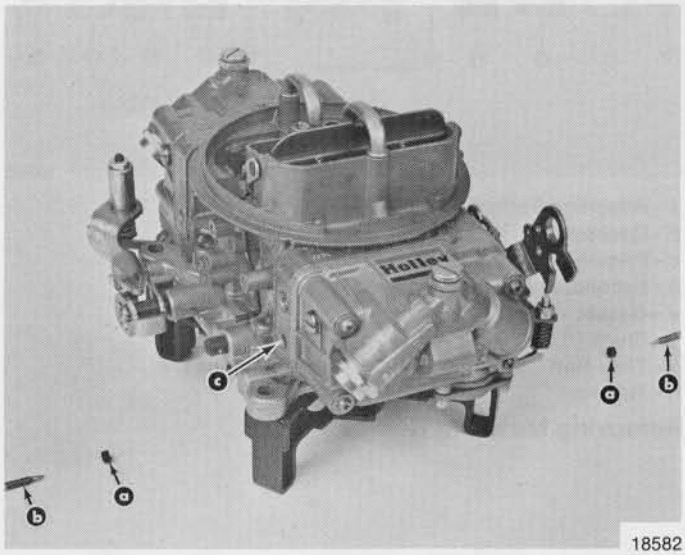
a - Choke Housing
b - Retaining Screws
c - Ground Wire
d - Vacuum Hose

Removing Choke Housing

FUEL BOWLS and METERING BODIES

IMPORTANT: As the rest of the carburetor is disassembled all of the parts from the primary side (of the carburetor) should be kept separated from secondary side parts. This will assure all of the parts are installed properly upon reassembly.

1. Remove fuel inlet filter nuts, gaskets, filters, and springs as outlined.
2. Remove idle mixture screws and gaskets.

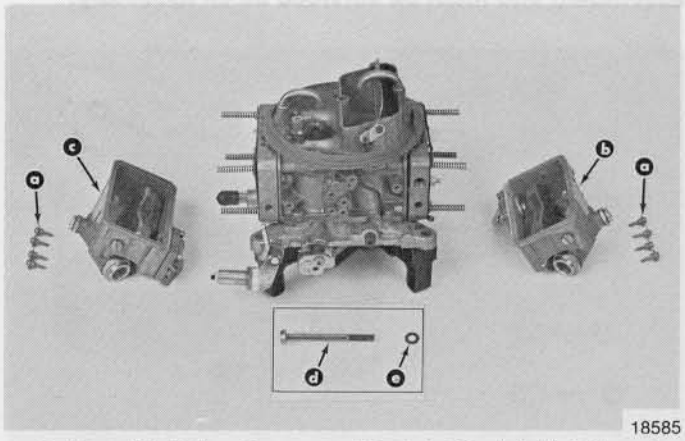


18582

a - Gaskets
b - Idle Mixture Screws
c - Idle Mixture Chamber (Only 1 Shown)

Removing Idle Mixture Screws

3. Remove primary and secondary fuel bowls.



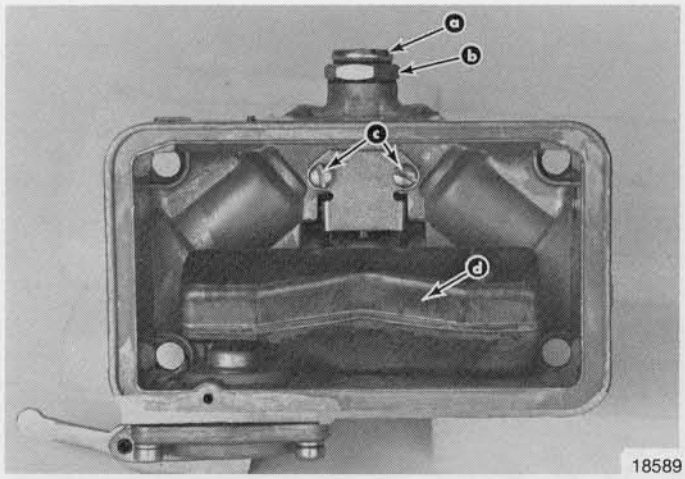
18585

a - Fuel Bowl Retaining Screws and Gaskets (Gaskets Not Shown) (If Used)
b - Primary Fuel Bowl
c - Secondary Fuel Bowl
d - Screws Used on 440/460 Cyclone
e - Gasket

Removing Fuel Bowls

IMPORTANT: Carburetors used on the 440/460 Cyclone engines will have long thru-bolts holding the fuel bowls onto the carburetor. Early carburetors used will be as shown. Later models may have long thru-bolts also.

4. Remove needle seat and float assembly from fuel bowls.
   a. Loosen locking screw.
   b. Turn adjustment nut counterclockwise to remove needle seat assembly.
   c. Remove float retaining screws and remove float.

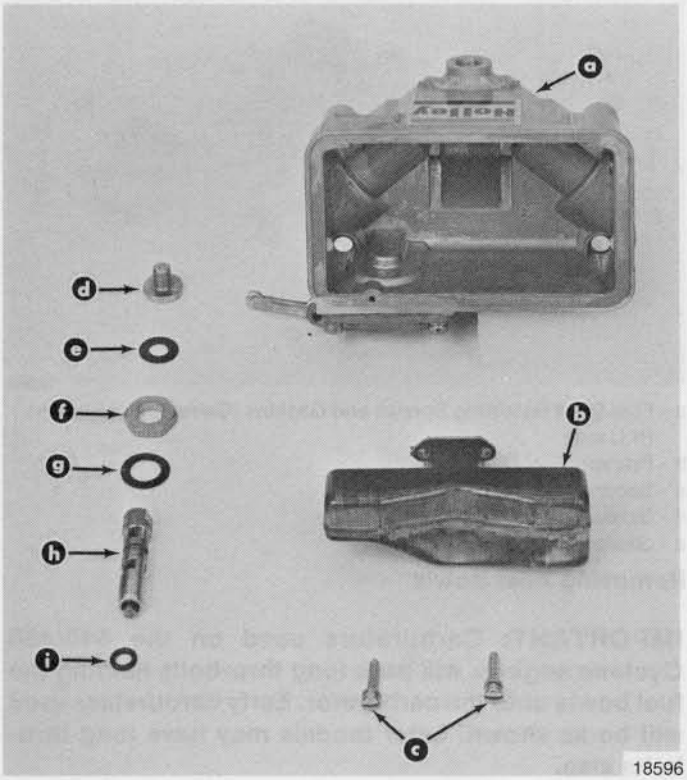


18589

a - Locking Screw
b - Adjustment Nut
c - Float Retaining Screws
d - Float

Removing Needle Seat and Float

IMPORTANT: Needle seat and needle are factory assembled and must be serviced as an assembly.

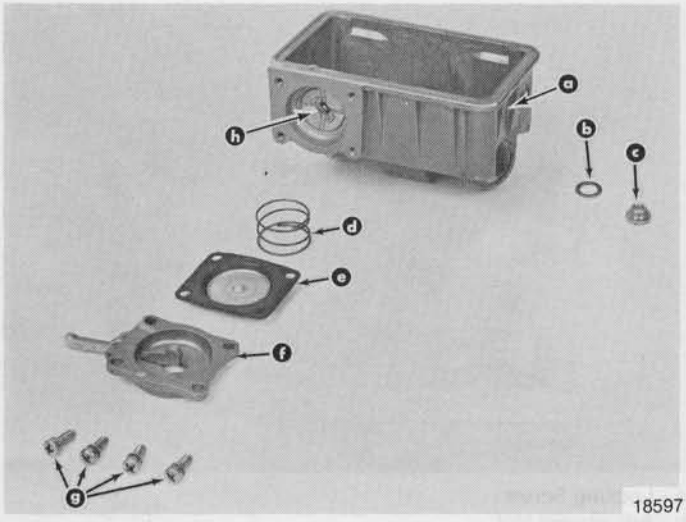


18596

a - Fuel Bowl
b - Float
c - Float Retaining Screws
d - Locking Screw
e - Gasket
f - Adjustment Nut
g - Gasket
h - Needle and Seat Assembly
i - "O" Ring

Needle and Seat and Float Assembly Removed

4. Remove accelerator pump assembly, sight plug and gasket.

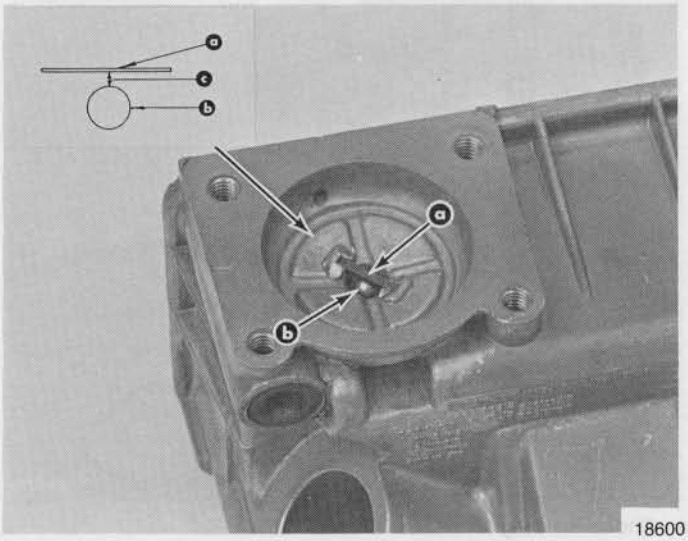


18597

a - Fuel Bowl
b - Gasket
c - Sight Plug
d - Pump Return Spring
e - Pump Diaphragm
f - Pump Housing
g - Pump Housing Retaining Screws
h - Pump Check Valve - NOT REMOVABLE

Accelerator Pump Removed

5. Accelerator pump check balls are not removable. Check for clearance between ball and retainer. Check ball must be free to move as specified.



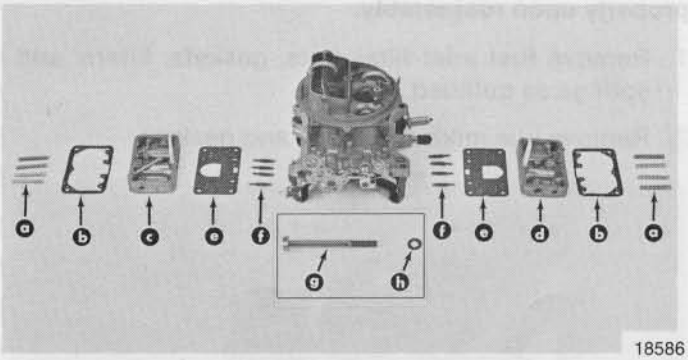
18600

a - Retainer
b - Check Ball
c - Refer to "Specifications"

Accelerator Pump Check Ball

6. Remove attaching springs, studs, gaskets, primary, and secondary metering bodies from carburetor.

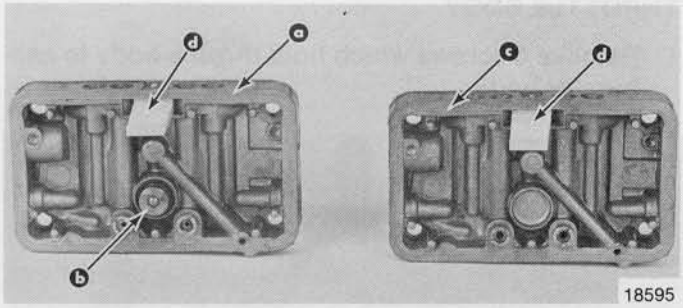
IMPORTANT: Some model carburetors will have long thru-bolts instead of the attaching springs and studs.



18586

a - Attaching Springs (If Used)
b - Gaskets
c - Primary Metering Body
d - Secondary Metering Body
e - Gasket
f - Studs (If Used)
g - Thru-Bolt Used on 440/460 Cyclone Engines
h - Gasket

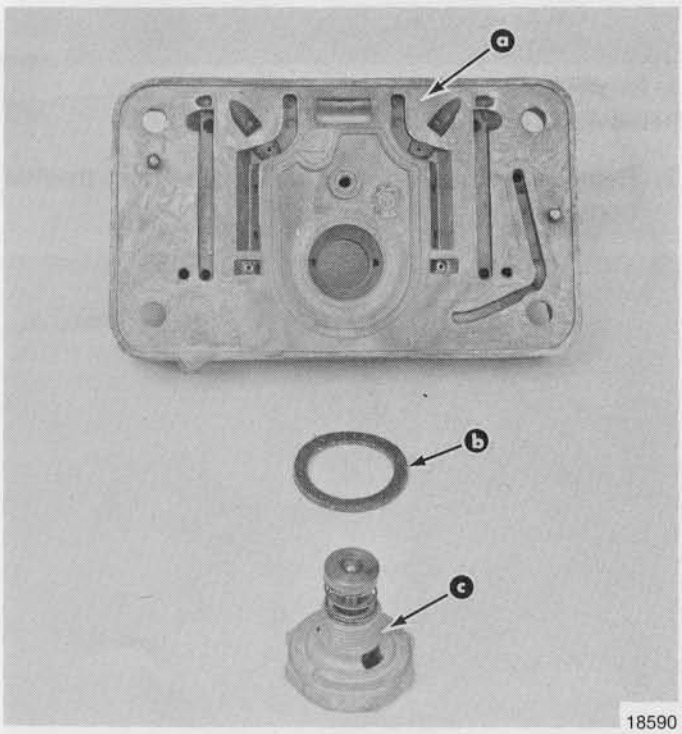
Removing Metering Bodies



a - Primary Metering Body
b - Power Valve
c - Secondary Metering Body (No Power Valve)
d - Float Bowl Vent Tubes

Metering Body Identification

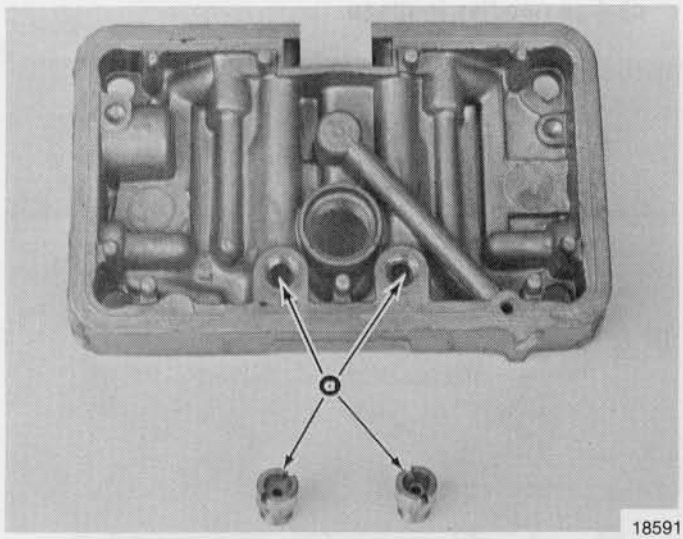
7. Remove power valve from primary metering body. Power valve cannot be serviced separately, if defective it must be replaced.



a - Primary Metering Body
b - Gasket
c - Power Valve

Power Valve Removed

8. Remove main fuel jets from primary and secondary metering bodies.

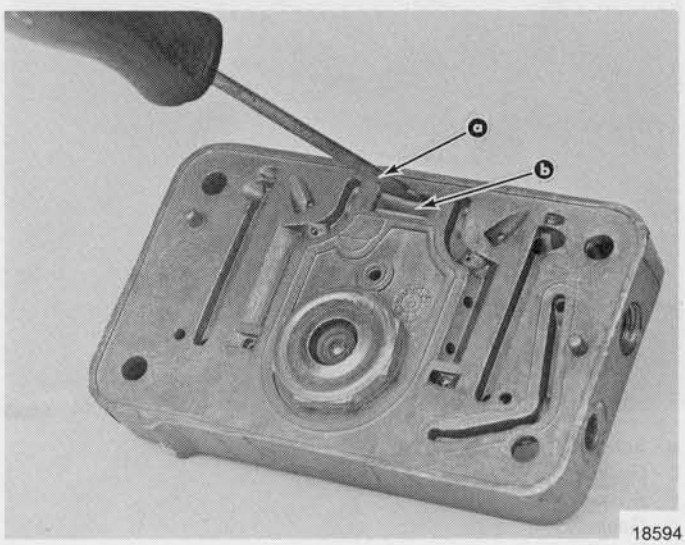


a - Main Fuel Jets

Main Fuel Jets Removed

9. Remove float bowl vent tubes. Pry down on tip of vent tube with a small screwdriver and pull out. Vent tubes are held on place with small locating pin.

IMPORTANT: Locating pins should not be removed from metering bodies.

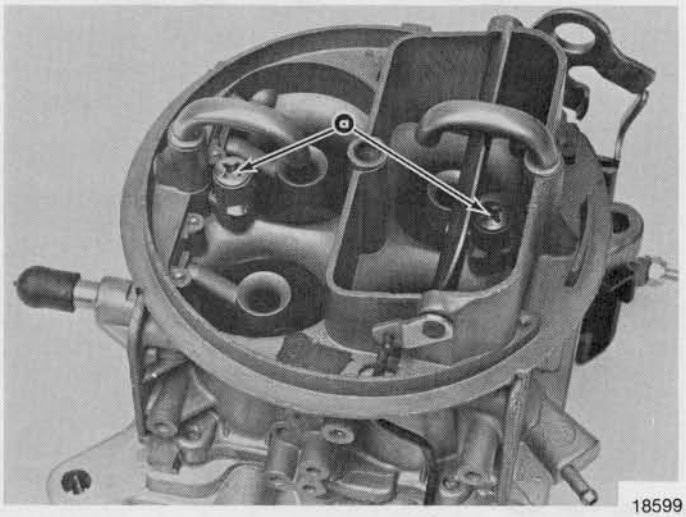


a - Small Screwdriver
b - Float Bowl Vent Tube

Removing Float Bowl Vent Tubes

CARBURETOR BODY

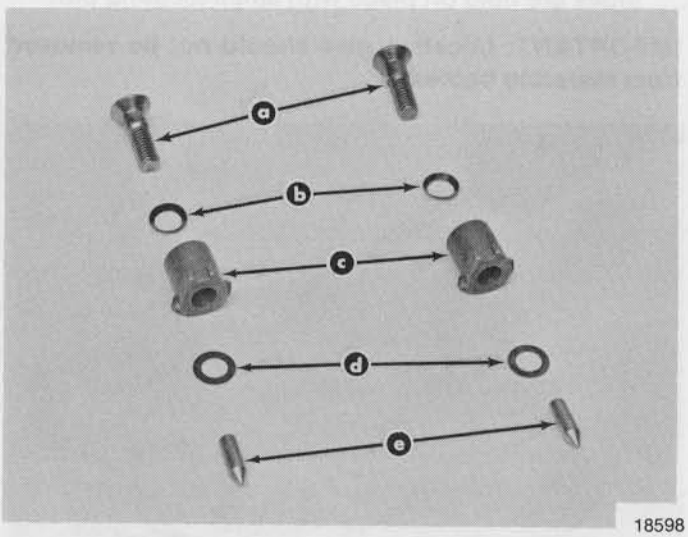
1. Remove 2 screws which hold accelerator pump discharge needles in place.



a - Screws

Accelerator Pump Discharge Needle Retaining Screws

2. Remove pump discharge needles and components.



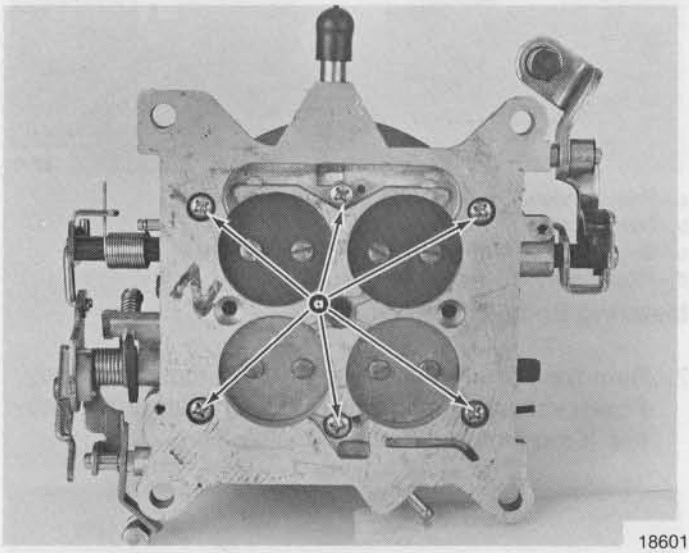
a - Screws
b - Gaskets
c - Bushings
d - Gaskets
e - Needles

Pump Discharge Needle Removed

IMPORTANT: Choke valves should not be removed from carburetor body, if damaged, carburetor body should be replaced.

THROTTLE BODY

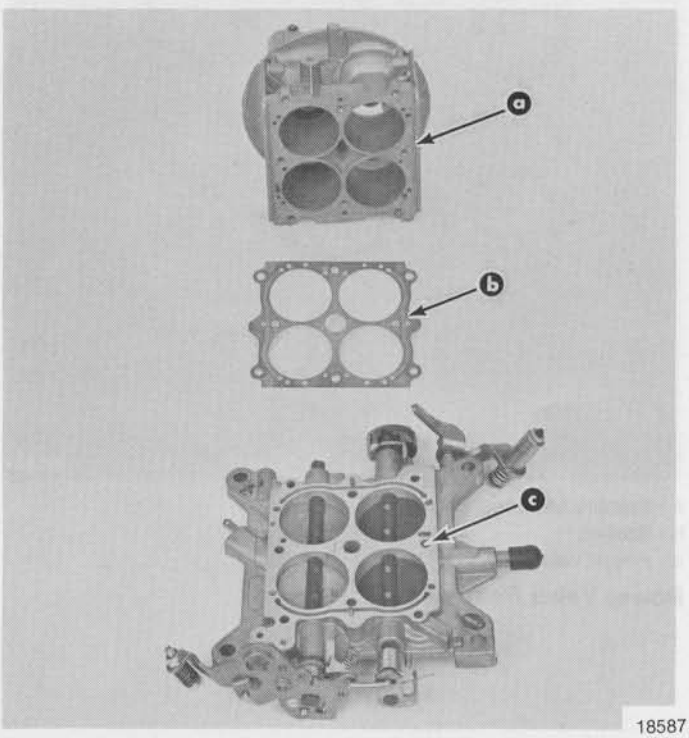
1. Remove 6 screws which hold throttle body to carburetor body.



a - Remove 6 Screws

Removing Throttle Body

2. Remove carburetor body and gasket from throttle body.



a - Carburetor Body
b - Gasket
c - Throttle Body

Throttle Body Removed From Carburetor Body

IMPORTANT: Further disassembly of the throttle body is normally not required. Throttle valves should not be removed. If throttle valves are damaged, throttle body should be replaced.

Cleaning and Inspection

Carbon, varnish, gum, dirt, and water contaminants in the carburetor or on exterior moving parts of the carburetor often are responsible for carburetion malfunctions. Therefore, carefully observe the following cleaning and inspection procedure, to obtain effective carburetor repair.

IMPORTANT: Do not use a wire or drill to clean jets, passages, or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

⚠CAUTION

Do not leave carburetor in carb cleaner for more than two hours.

IMPORTANT: Do not clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and component replacement will be necessary.

⚠CAUTION

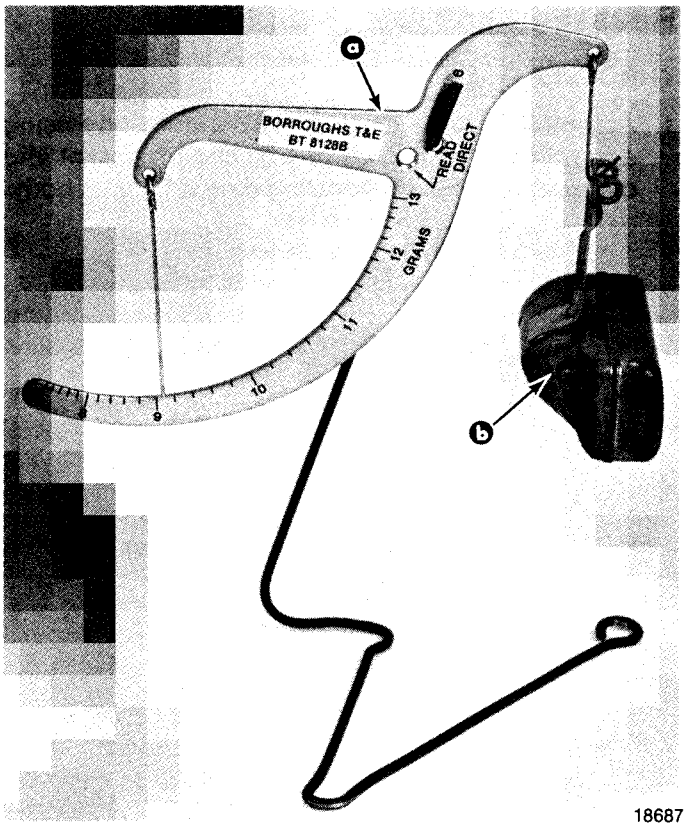
Any plastic, rubber, or neoprene parts should not be immersed in carburetor cleaner, as they will swell, harden or distort.

IMPORTANT: All gaskets, "O" rings, and seals should be replaced during carburetor repair.

1. Thoroughly clean all metal parts in a commercial carburetor cleaner, until all deposits have been removed. Follow manufacturer's instructions of cleaner being used for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage; pay particular attention to the following:
   a. **Float Needle and Seat:** If float needle or seat is worn or damaged, replace with a new needle and seat assembly.

IMPORTANT: Float needle and seat are factory assembled. Needle and seat cannot be serviced separately.

   b. **Float Assembly and Hinge Pin:** Inspect float pontoon for deterioration and porosity. Check pontoon density (to see if it is saturated with fuel), by comparing weight of float with specifications. If pontoon weight is high, float assembly MUST BE replaced. Shake float. If float contains fuel inside, float is leaking and must be replaced. Check hinge pin and holes for wear.
   c. **Fuel and Air Passages:** Passages MUST BE perfectly clean for proper carburetor operation.



18687

a - Scale
b - Float

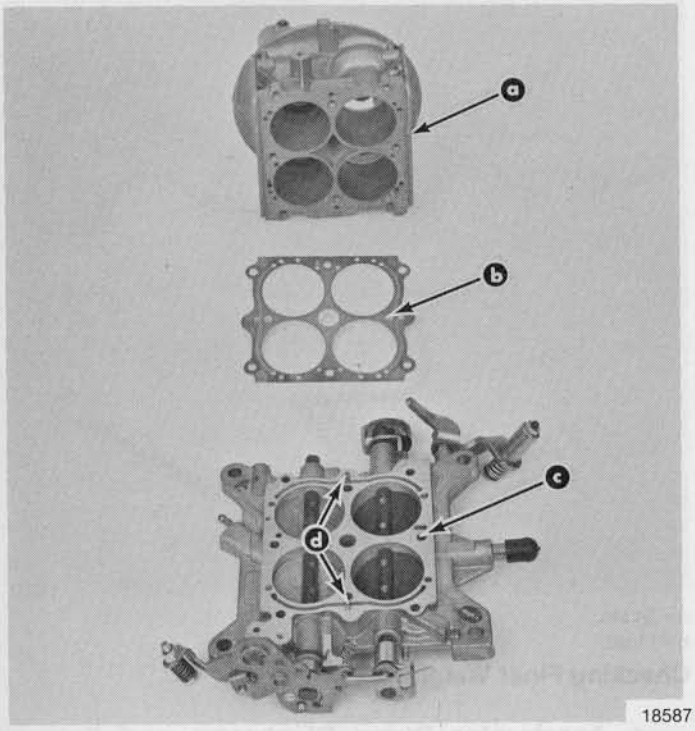
Checking Float Weight

   d. **Accelerator Pump Diaphragm and Return Spring:** Inspect pump diaphragm, check ball, discharge needles, and return spring.
   e. **Power Piston Spring:** Check power piston spring for weakness or distortion.
   f. **Idle Mixture Needles:** Inspect idle mixture needles. If damaged, needles MUST BE replaced.
   g. **Levers and Linkages:** Check levers, links and rods for wear.
   h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Check throttle valve and shaft for binding thru entire operating range, making sure valve opens and closes completely. Throttle body assembly MUST BE replaced if throttle valve and shaft are worn or damaged.
   i **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding thru entire operating range, making sure valve opens and closes completely. Carburetor body assembly MUST BE replaced if choke valve and shaft and lever assembly are worn or damaged.
   j. **Inspect casting** for visible damage. Inspect gasket surfaces.

Reassembly

THROTTLE BODY

1. Assemble throttle body to carburetor body using a new gasket, being careful to line up gasket and carburetor body with locating pins in throttle body.

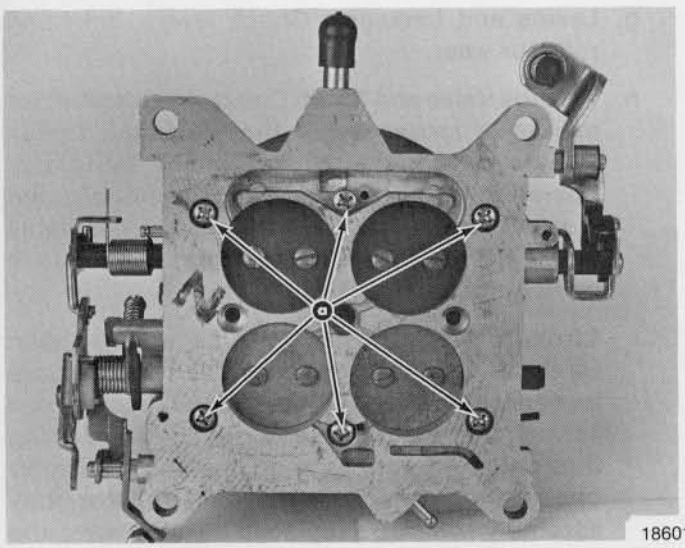


18587

a - Carburetor Body
b - New Gasket
c - Throttle Body
d - Locating Pins

Installing Throttle Body

2. Install throttle body attaching screws and tighten evenly and securely.



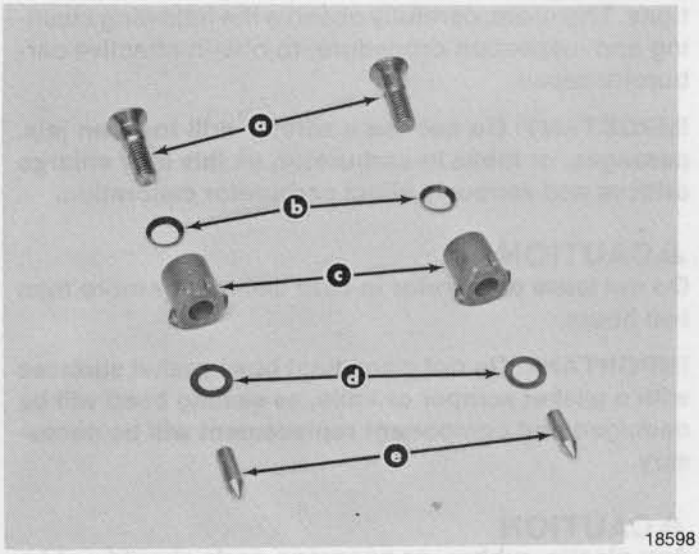
18601

a - 6 Attaching Screws

Installing Attaching Screws

CARBURETOR BODY

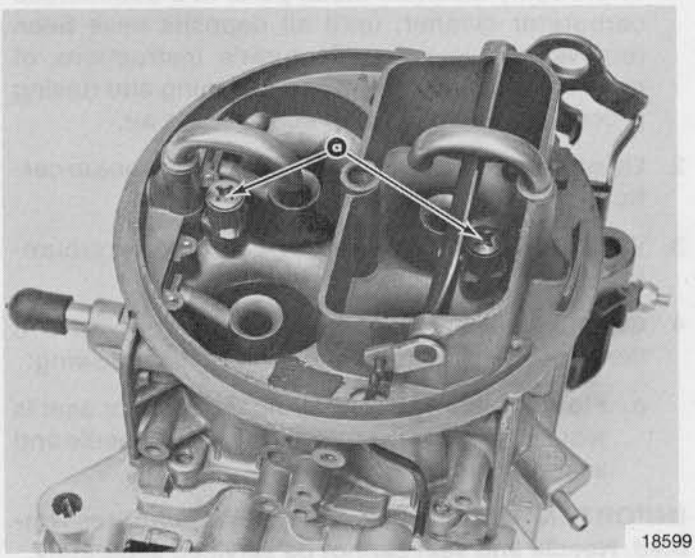
1. Install pump discharge needles into carburetor body in order shown. Tighten screws securely.



18598

a - Screws
b - Gaskets
c - Bushings
d - Gaskets
e - Needles

Installing Pump Discharge Needles



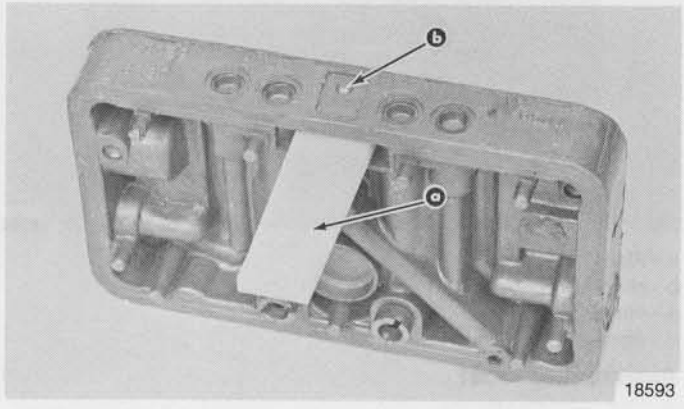
18599

a - Pump Discharge Needle Retaining Screws

Retaining Screws Installed

FUEL BOWLS and METERING BODIES

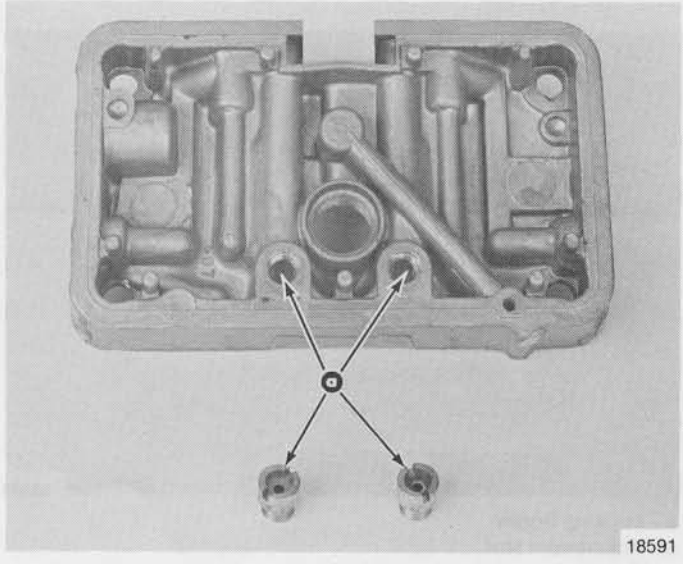
1. Install fuel bowl vent tubes into metering bodies, vent tube must be pushed in far enough to lock into locating pin.



a - Vent Tube
b - Locating Pin

Installing Vent Tubes

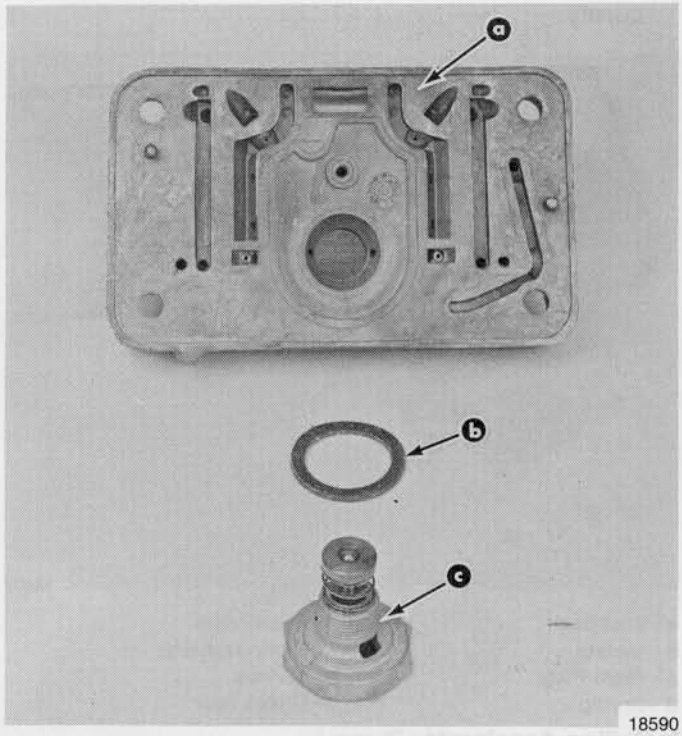
2. Install primary and secondary main fuel jets.



a - Main Fuel Jets

Installing Main Fuel Jets

3. Install power valve and new gasket in primary metering body.

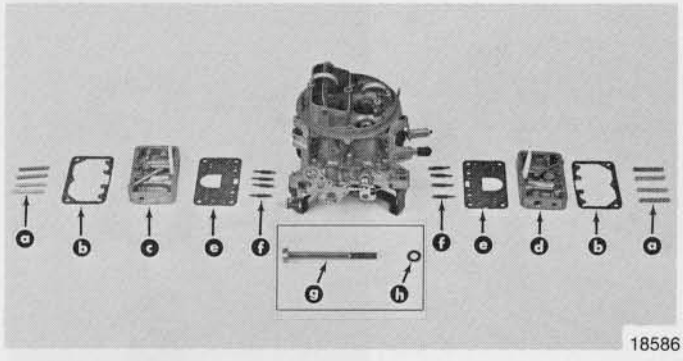


a - Primary Metering Body
b - Gasket
c - Power Valve

Installing Power Valve

4. Assembly metering bodies to carburetor body in order shown.

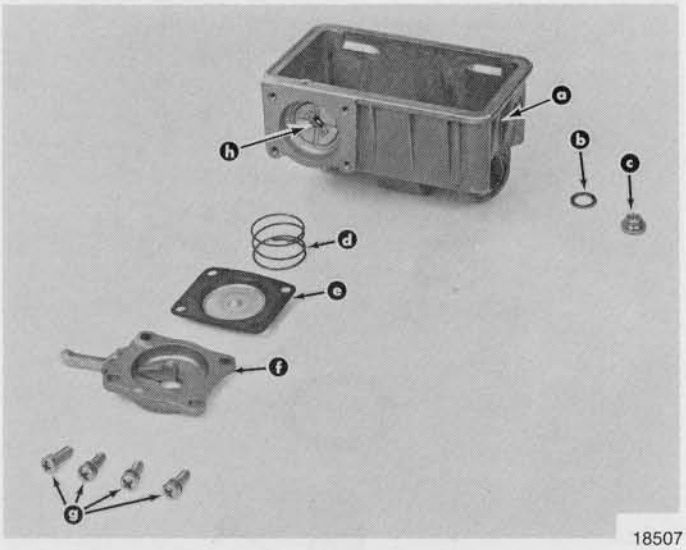
IMPORTANT: On 440/460 Cyclone carburetors this operation cannot be performed until fuel bowls are assembled because the carburetor has through bolts in place of the springs.



a - Springs
b - Gasket
c - Primary Metering Body
d - Secondary Metering Body
e - Gasket
f - Studs (If Used)
g - Thru-Bolts (440/460 Cyclone)
h - Gasket

Installing Metering Bodies

5. Install accelerator pump assembly as shown.
6. Install sight plug and gasket. Tighten screws securely.

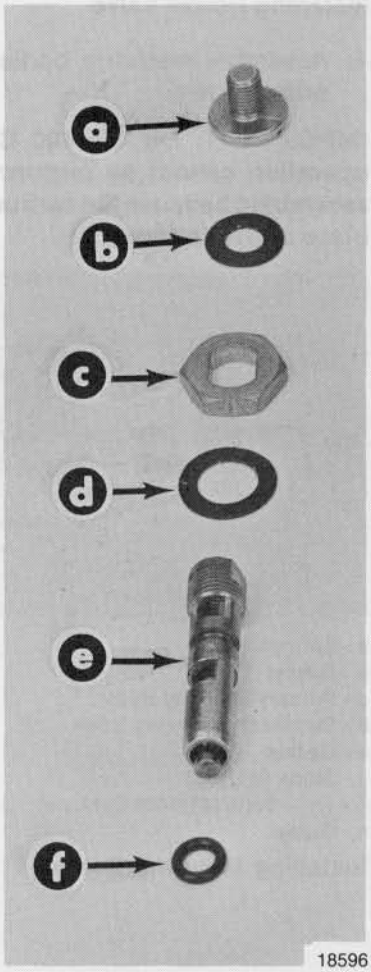


18507

a - Fuel Bowl
b - Gasket
c - Sight Plug
d - Spring
e - Diaphragm
f - Pump Housing
g - Screws
h - Check Ball

Installing Accelerator Pump

7. Assemble needle seat as shown.

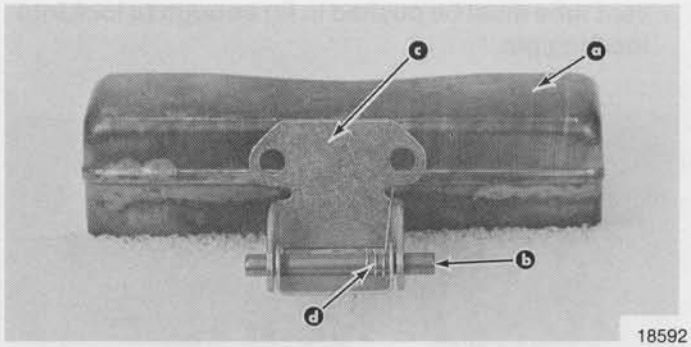


18596

a - Locking Screw
b - Gasket
c - Adjustment Nut
d - Gasket
e - Needle Seat Assembly
f - "O" Ring

Needle Seat Assembly

8. Assemble float, spring, hinge, and hinge pin as shown.

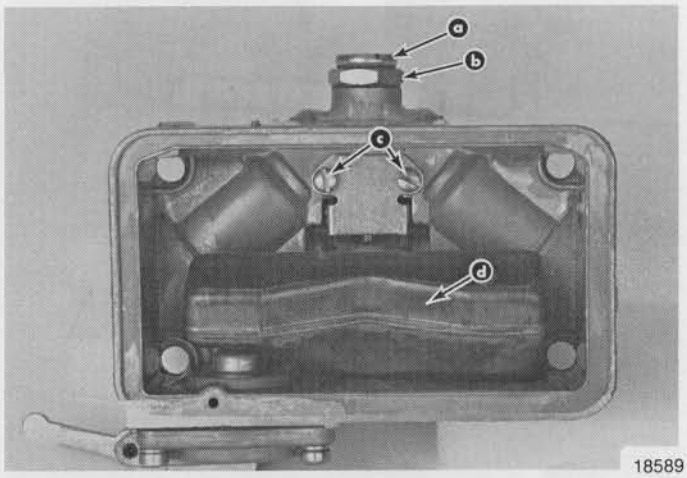


18592

a - Float
b - Hinge Pin
c - Hinge
d - Spring

Assembling Float

9. Install float, and float retaining screws. Tighten screws securely. Install needle seat assembly. Adjust float to specifications. See "Adjustments" in this section.

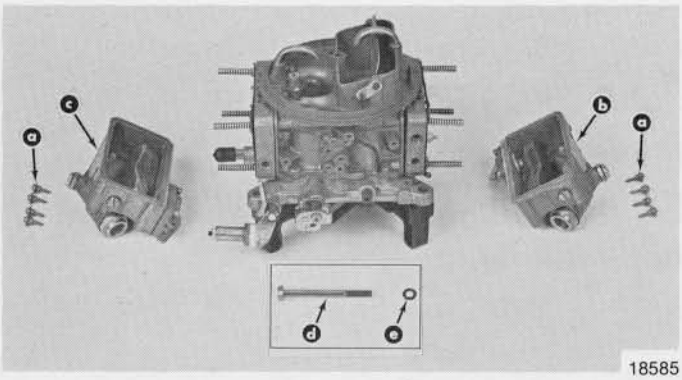


18589

a - Locking Screw
b - Adjustment Nut
c - Float Retaining Screws
d - Float

Installing Float and Needle Seat

10. Install fuel bowls as shown. Tighten screws securely.

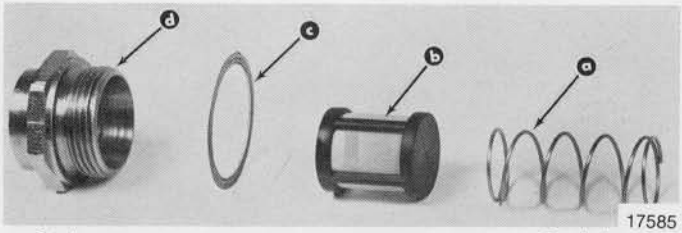


18585

a - Screw and Gaskets (If Used)
b - Primary Fuel Bowl
c - Secondary Fuel Bowl
d - Thru-Bolts (440/460 Cyclone)
e - Gasket

Installing Fuel Bowls

11. Install fuel inlet filter components, fuel inlet gasket, and nut as shown. Tighten nut securely.



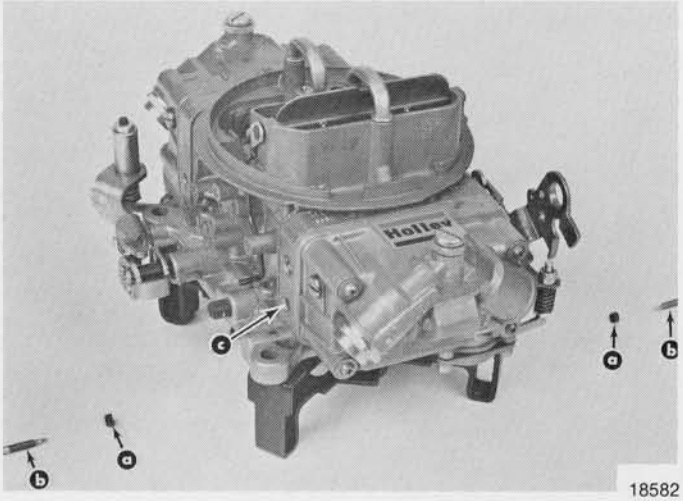
17585

a - Spring
b - Filter (Open End Towards Nut)
c - Gasket
d - Fuel Inlet Nut

Installing Filter and Inlet Nut

12. Install idle mixture screws and gaskets. Lightly seat needle, then back out 2 turns.

IMPORTANT: Do not tighten idle mixture needles against seats or damage to needle and/or seat may result.



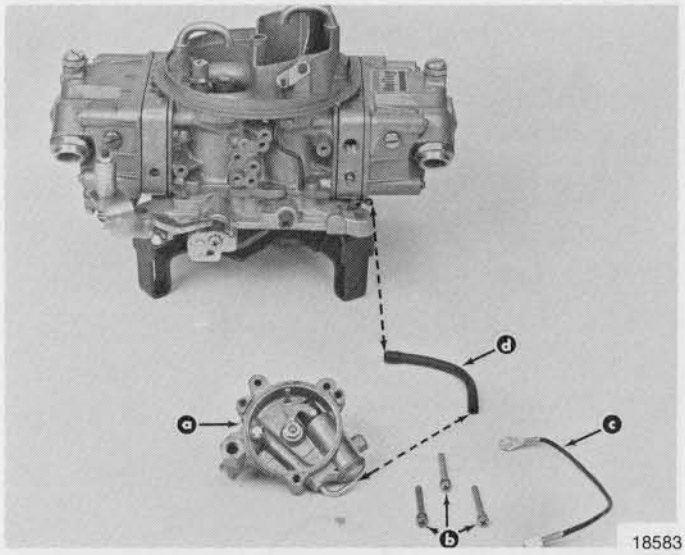
18582

a - Gaskets
b - Needles
c - Idle Mixture Hole (Only One Shown)

Installing Idle Mixture Screws

CHOKE HOUSING

1. Install choke housing as shown. Tighten screws securely.

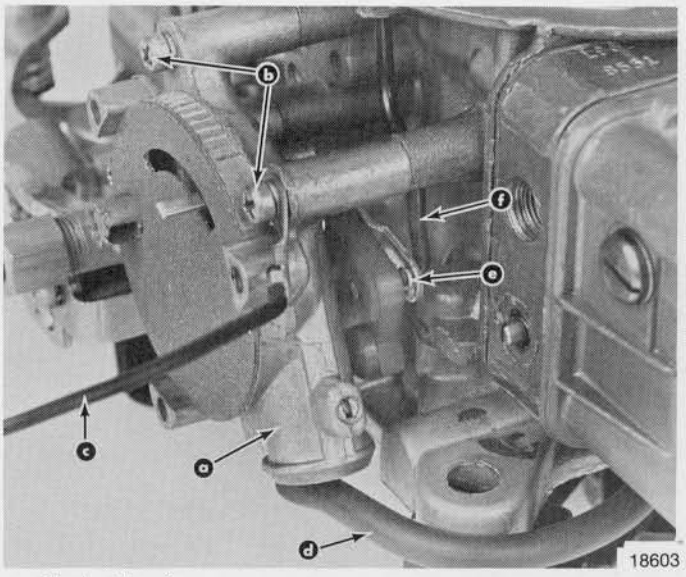


18583

a - Choke Housing
b - Screws
c - Ground Wire
d - Vacuum Hose

Installing Choke Housing

2. Install choke rod retaining clip.

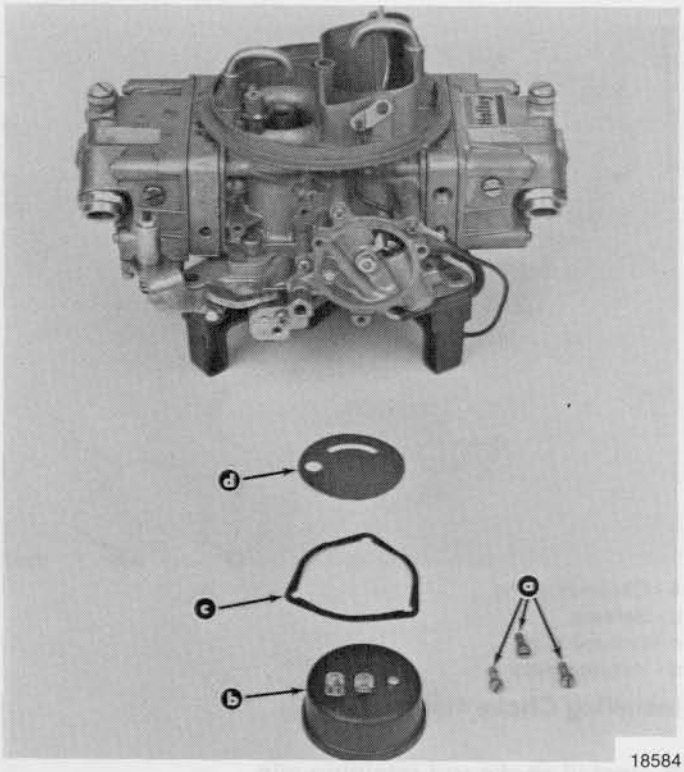


18603

a - Choke Housing
b - Screws
c - Ground Wire
d - Vacuum Hose
e - Choke Rod Retaining Clip
f - Choke Rod

Retaining Clip Installed

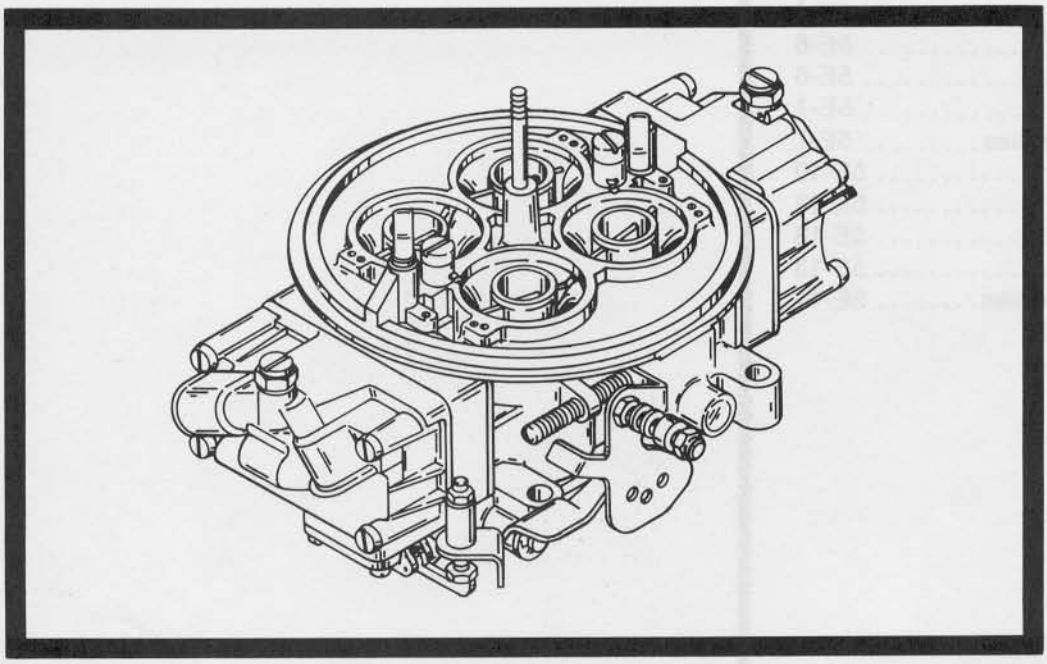
3. Install choke cover as shown. Adjust choke to "Specifications". Tighten screws securely. Be sure to hook choke heat element into choke lever.



a - Choke Cover Retaining Screws
b - Choke Cover
c - Retainer
d - Gasket

Install Choke Cover

FUEL SYSTEM



HOLLEY 4 BARREL
Model 4500

5

E

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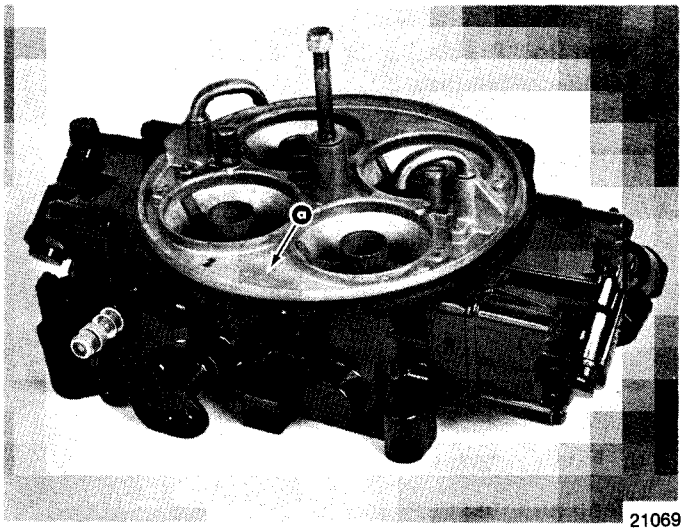
Identification



a - Part Number

Holley Part Number Location

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	MCM 575 Lbs. Ft. (N.m)
Carburetor to Manifold	20 (27)
Fuel Line To Carburetor	18 (24)
Fuel Inlet Filter Nut	Securely

Tools

MERCURY MARINE SPECIAL TOOLS	
91-59339	Tachometer
91-36392	Universal Carburetor Gauge

BORROUGHS TOOLS AND EQUIPMENT 2429 N. BURDICK ST. KALAMAZOO, MICHIGAN 49007 (616) 345-5163	
BT8128B	Float Gram Scale

Specifications

Engine Model	MCM 575
Make	Holley
Model	4500
Holley Part No.	8082
Mercury Part No.	1393-8862
Main Primary Jets	.088 thru .092
Main Secondary Jets	.088 thru .092
Accelerator Pump	.015 (.4mm)
Accelerator Pump Check Ball	.015" (4mm)
Float Adjustment	Bottom of Sight Plug Hole ±1/32" (.8mm)
Float Weight	15.6 Grams Max.
Preliminary Idle Mixture Setting	1-1/4 Turns

Description

The Holley model 4500 is a dual feed, double pump carburetor. This means each fuel bowl has a seperate fuel inlet and there 2 accelerator pumps, one for the primary side and one for the secondary side. Beween the fuel bowls and the carburetor body, metering bodies are located. The metering bodies contain the main jets, power valve, and the majority of the metered passages in the carburetor. Both the primary and secondary floats have an external float adjustment.

Precautions

⚠WARNING
Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING
Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key "OFF". Do not smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING
Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". Do not smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING
Make sure no fuel leaks exist, before closing engine hatch.

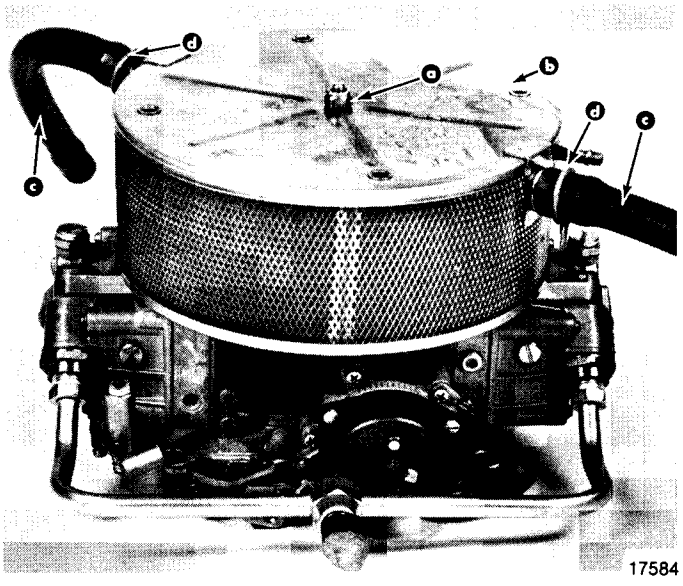
⚠CAUTION
Do not operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Maintenance

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

Flame Arrestor

1. Remove (in the following order):
   a. Nut.
   b. Washer (Not Shown).
   c. Hose clamps and crankcase ventilation hoses - From flame arrestor and rocker arm covers.
   d. Flame arrestor - Lift from carburetor.
2. Clean and Inspect:
   a. Clean flame arrestor by blowing it out with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hose for cracks or deterioration, replace if neccessry.
3. Install (in the following order):
   a. Flame arrestor - Place on carburetor.
   b. Crankcase ventilation hoses and clamps - To flame arrestor and rocker arm covers.
   c. Washer (Not Shown).
   d. Nut - Tighten securely, do not overtighten.



17584

a - Nut
b - Flame Arrestor
c - Crankcase Ventilation Hoses
f - Clamps

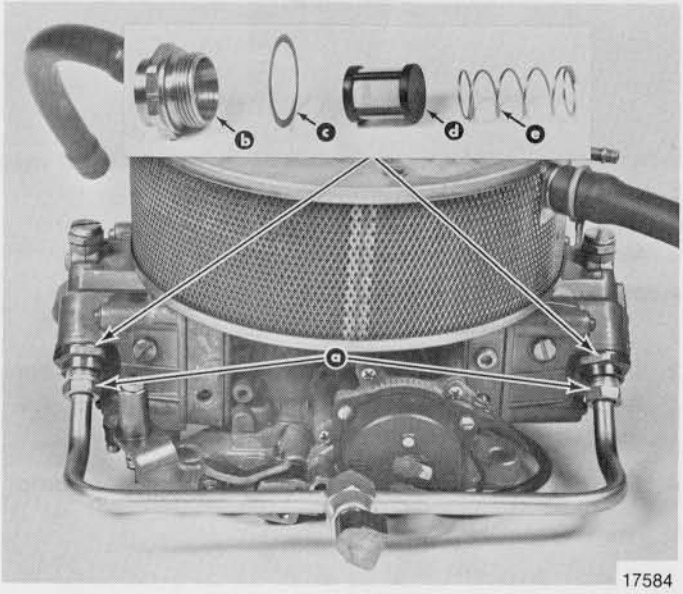
Flame Arrestor

Fuel Filters

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

Carburetor inlet filters are located in float chamber assemblies behind fuel inlet fittings. To replace filters proceed as follows:

1. Remove fuel line from fuel inlet filter nuts.
2. Remove fuel inlet filter nut, gasket, filter and spring from each float chamber assembly. (Discard gasket and filter).
3. Clean nuts and springs in solvent and dry with compressed air.
4. Install spring, new filter (with open end outward), gasket and fuel inlet filter nut into each float chamber assembly (in that order). Tighten nut securely.
5. Reconnect fuel line and tighten securely.
6. Run engine and check for gasoline leaks.



a - Fuel Line Fittings
b - Fuel Filter Nut
c - Filter Nut Gasket
d - Filter
e - Spring

Typical Fuel Inlet Filters

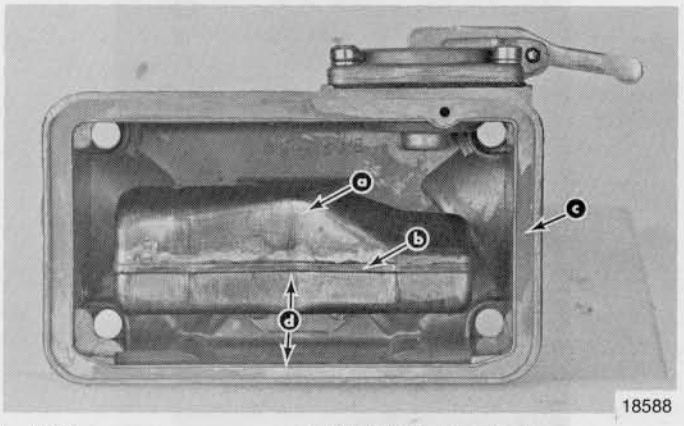
Adjustments

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

Preliminary Float Adjustment

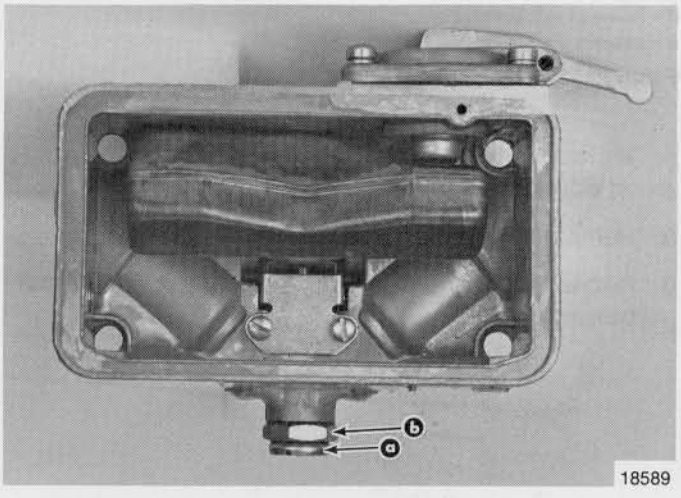
IMPORTANT: The preliminary float adjustment will provide a sufficient setting for starting the engine. Final float adjustments must be made with engine running.

1. Invert float bowl as shown.
2. Loosen locking screw and turn float adjustment nut to adjust float.
3. Proper float adjustment is achieved when parting line on float is parallel with fuel bowl. Parting line must be parallel all the way around float.



a - Float
b - Float Parting Line
c - Fuel Bowl (Inverted)
d - Parallel All The Way Around Float

Preliminary Float Setting



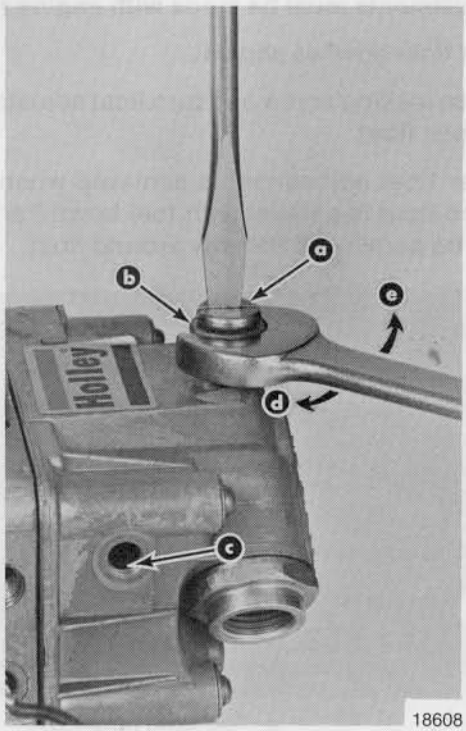
a - Locking Screw
b - Adjustment Nut

Adjusting Float Level

4. Repeat this procedure for both floats.

Final Float Adjustment

1. With carburetor mounted on engine, start engine and leave run for several minutes.
2. While engine is running remove sight plug on primary fuel bowl.
3. Loosen locking screw and turn adjustment nut slowly until fuel can be seen even with the bottom of the sight plug hole.



18608

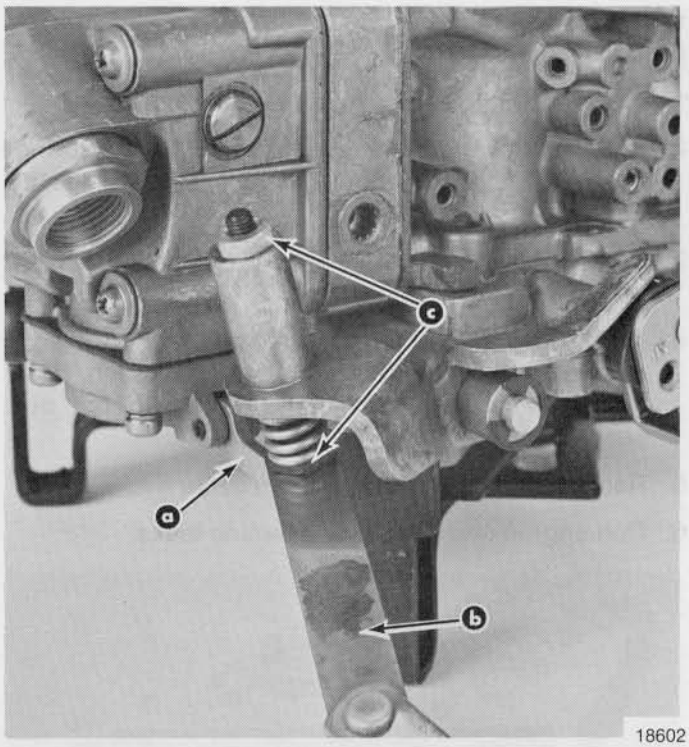
a - Locking Screw
b - Adjustment Nut
c - Sight Plug Hole
d - Raises Fuel Level
e - Lowers Fuel Level

Final Float Adjustment

4. Tighten locking screw securely being careful not to let adjustment nut turn.
5. Reinstall sight plug and gasket.
6. Repeat this procedure for secondary side of carburetor.

Accelerator Pump

1. With engine shut off, move throttle arm to W.O.T. position.
2. While holding throttle arm in W.O.T. position push down on primary accelerator pump lever.



18602

a - Pump Lever - Push Down
b - Feeler Gauge
c - Adjustment Screw and Nut

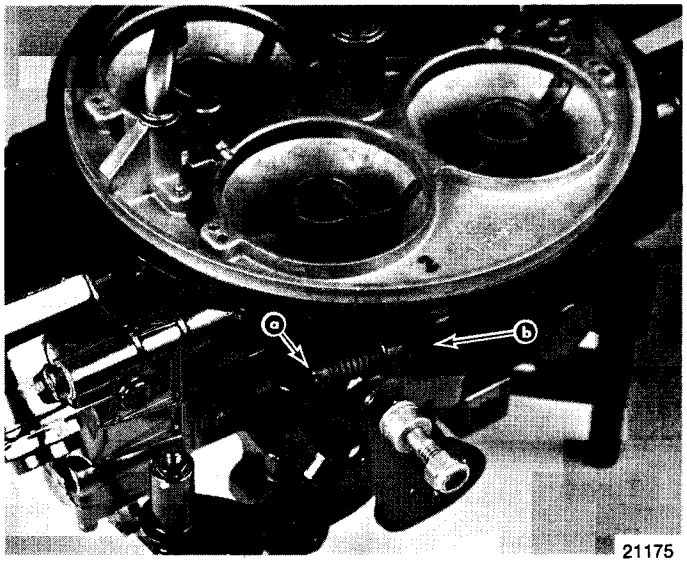
Accelerator Pump Adjustment

3. With a feeler gauge check for clearance between adjustment screw and accelerator pump lever. Adjust screw and nut to specifications.
4. Repeat procedure for secondary accelerator pump.

Preliminary Idle Speed and Mixture

IMPORTANT: The following adjustments will provide a sufficient setting to start engine. Final adjustments must be made with engine running.

1. Turn idle speed screw in until it just contacts idle stop then turn screw in one additional turn.

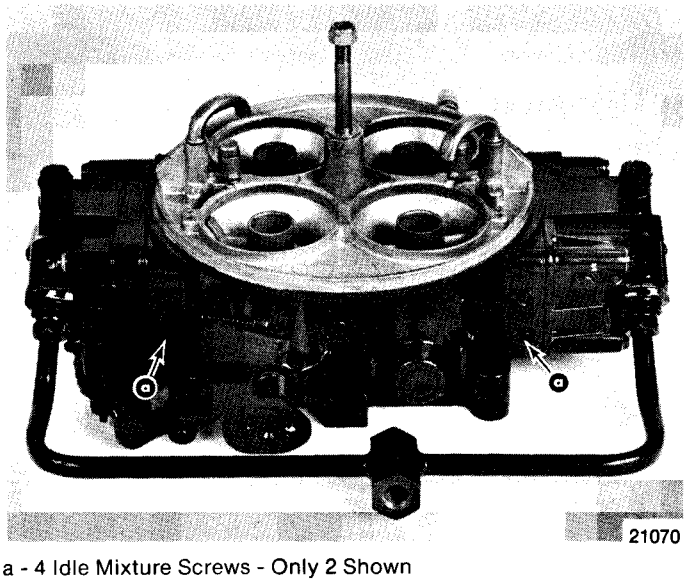


a - Idle Speed Screw
b - Idle Stop

Idle Speed Screw

IMPORTANT: Do not turn idle mixture needles tightly against seat (in the following step), as damage to seat and/or needle may result.

2. Turn idle mixture needles in until they LIGHTLY SEAT; then back out 1-1/4 turn.



a - 4 Idle Mixture Screws - Only 2 Shown

Idle Mixture Screws

Final Idle Speed and Mixture

IMPORTANT: Boat must be in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles smoothly within range given under "Specifications", following, with boat in the water, engine at normal operating temperature and drive unit in forward gear. to adjust idle speed and mixture, proceed as follows:

IMPORTANT: Do not attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

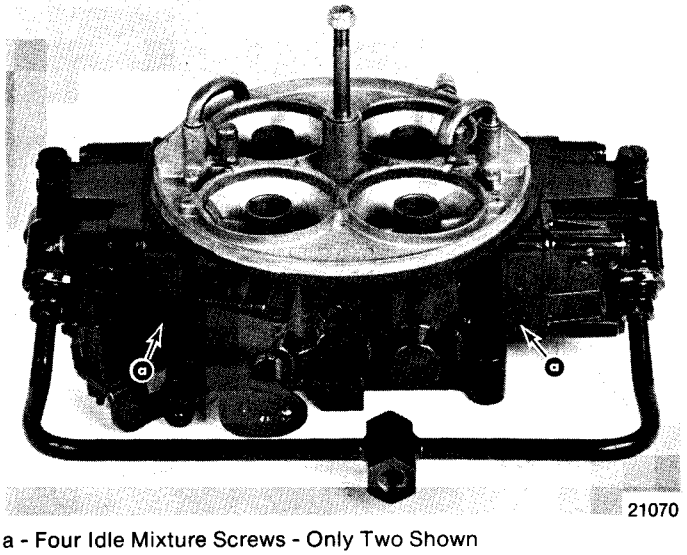
1. Connect a shop tachometer to engine.

IMPORTANT: Do not turn idle mixture needle tightly into set (in next step), as damage to needle and/or seat may result.

2. If a new or rebuilt carburetor has been installed, turn idle mixture needles in (clockwise) until it LIGHTLY contacts seat; then, back out needle 1-1/4 turns. This will provide a sufficient setting to allow starting engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠WARNING

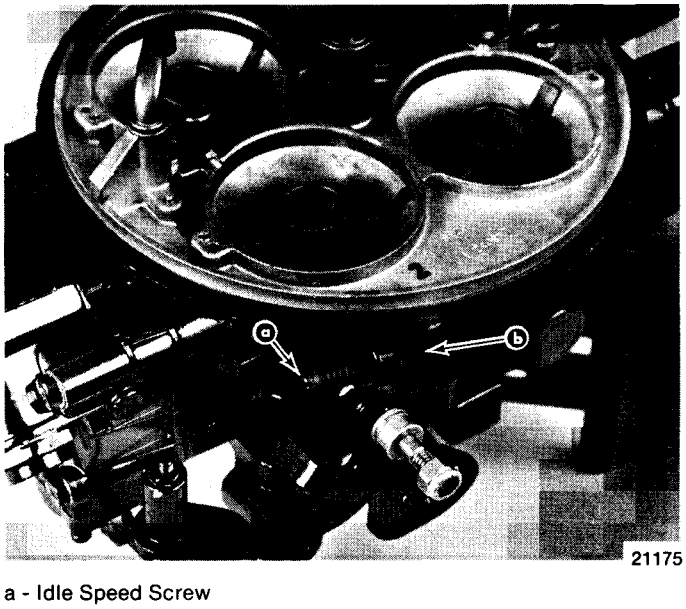
Do not leave the helm unoccupied while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.



a - Four Idle Mixture Screws - Only Two Shown

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable brass barrel from anchor stud.
6. Adjust idle speed adjustment screw to obtain specified RPM.
7. With engine running at specified RPM, adjust mixture needle, as follows:
   a. Turn idle mixture needle inward (clockwise) until the engine speed begins to drop due to lean mixture.
   b. Turn idle mixture screw outward (counterclockwise) until the speed begins to drop due to lean mixture.
   c. Turn screw inward to a point between these two extemes to obtain maximum engine smoothness and RPM.
   d. Repeat procedure with other needle.
   e. Readjust idle speed adjustment screw, if necessary, to obtain specified RPM.

IMPORTANT: Refer to "Section 2, Part H" for throttle cable installation and adjustment.



a - Idle Speed Screw
b - Idle Stop

Idle Speed Adjustment

Repair

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

Removal

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may, then, be inspected for contamination as carburetor is disassembled.

1. Remove crankcase ventilation hoses from flame arrestor; then, remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and and foreign material from falling into bores.

2. Turn fuel supply off at fuel tank.
3. Disconnect throttle cable from carburetor.
4. Remove fuel lines. Refer to "Fuel Inlet Filter".
5. Remove fuel pump sight tube.
6. Remove carburetor attaching nuts and washers and remove carburetor.
7. Remove and discard gaskets.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

Installation

1. Thoroughly clean gasket surfaces. Use care to prevent gasket material from entering intake manifold.
2. Place new carburetor base gasket on intake manifold. Install carburetor and secure with nuts and washers. Torque to specifications.
3. Connect fuel lines to fuel inlet nuts and torque to specifications.
4. Connect fuel pump sight tube.
5. Move throttle lever back-and-forth and check for binding in throttle linkage.
6. Install throttle cable, as explained, in "Section 2.
7. Install flame arrestor and crankcase ventilation hoses.

8. Reconnect battery cables to battery.
9. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
10. Adjust idle speed and idle mixture, as outlined under "Adjustments", preceding.

Disassembly

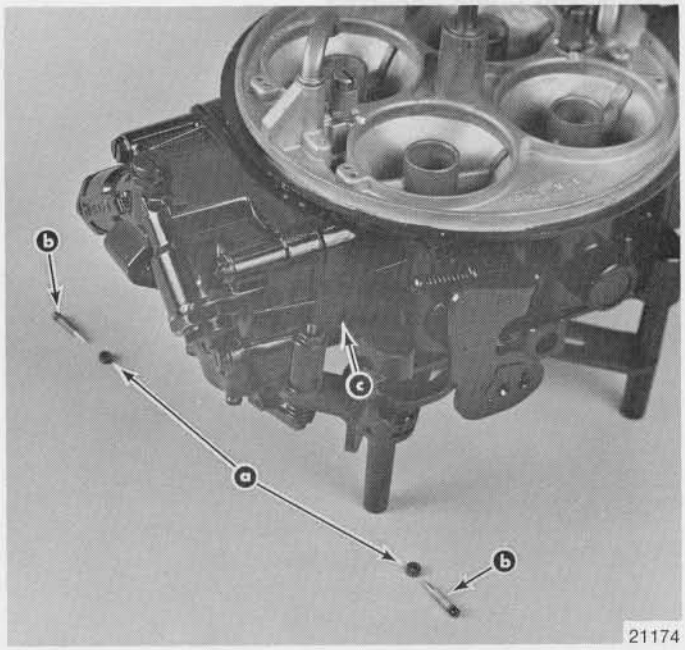
The following is a step-by-step procedure for completely overhauling carburetor removed from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing any unnecessary steps.

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

FUEL BOWLS and METERING BODIES

IMPORTANT: As the rest of the carburetor is disassembled all of the parts from the primary side (of the carburetor) should be kept separated from secondary side parts. This will assure all of the parts are installed properly upon reassembly.

1. Remove fuel inlet filter nuts, gaskets, filters, and springs as outlined.
2. Remove idle mixture screws and gaskets.

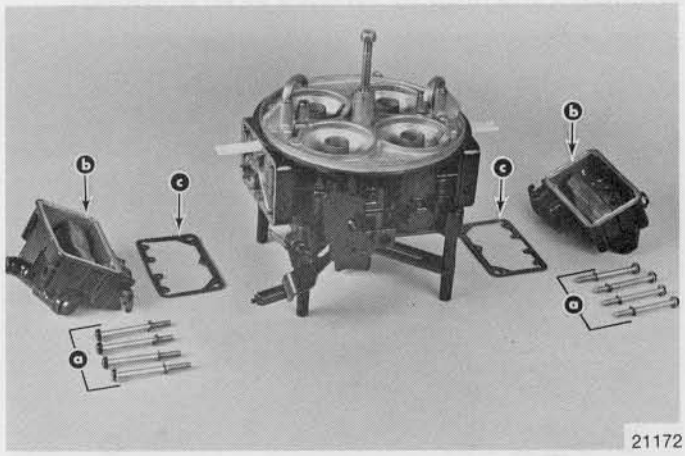


21174

a - Gaskets
b - Idle Mixture Screws
c - Idle Mixture Chamber (Only 1 Shown)

Removing Idle Mixture Screws

3. Remove primary and secondary fuel bowls.

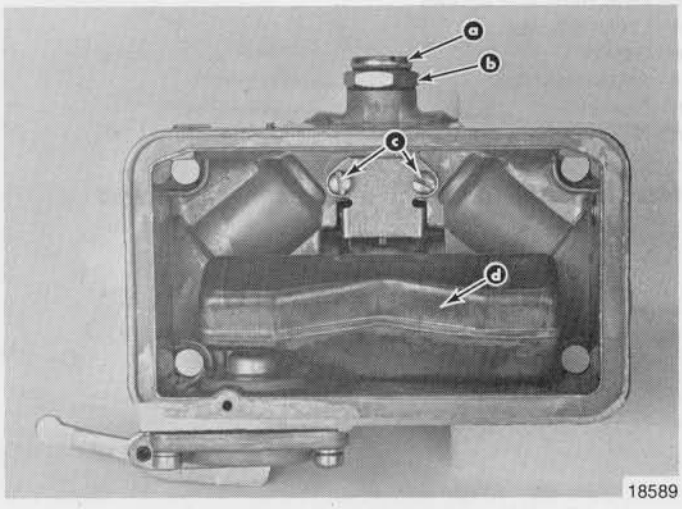


21172

a - Fuel Bowl Retaining Screws and Gaskets
b - Fuel Bowl
c - Fuel Bowl Gasket

Removing Fuel Bowls

4. Remove needle seat and float assembly from fuel bowls.
   a. Loosen locking screw.
   b. Turn adjustment nut counterclockwise to remove needle seat assembly.
   c. Remove float retaining screws and remove float.

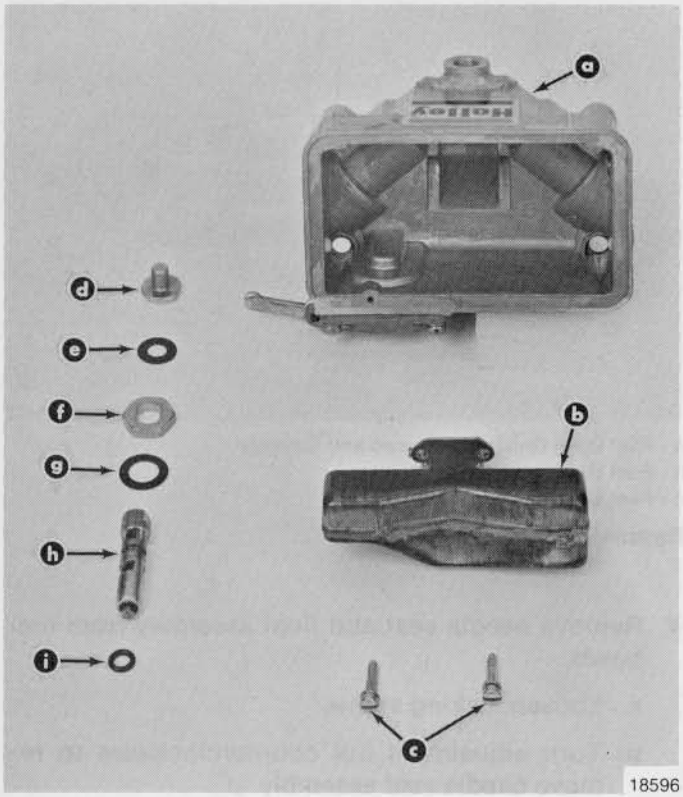


18589

a - Locking Screw
b - Adjustment Nut
c - Float Retaining Screws
d - Float

Removing Needle Seat and Float

IMPORTANT: Needle seat and needle are factory assembled and must be serviced as an assembly.

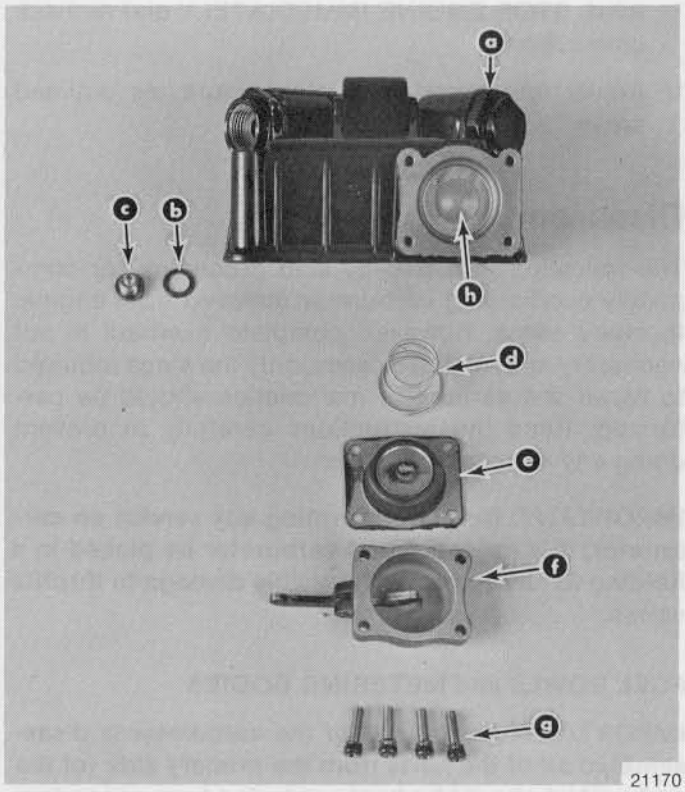


18596

a - Fuel Bowl
b - Float
c - Float Retaining Screws
d - Locking Screw
e - Gasket
f - Adjustment Nut
g - Gasket
h - Needle and Seat Assembly
i - "O" Ring

Needle and Seat and Float Assembly Removed

4. Remove accelerator pump assembly, sight plug and gasket.

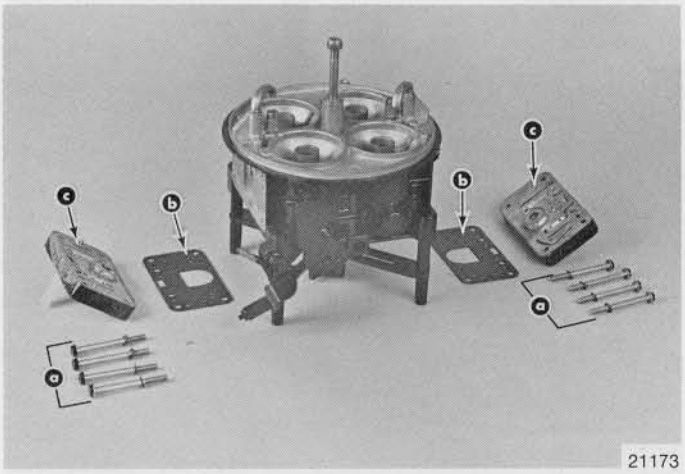


21170

a - Fuel Bowl
b - Gasket
c - Sight Plug
d - Pump Return Spring
e - Pump Diaphragm
f - Pump Housing
g - Pump Housing Retaining Screws
h - Pump Check Valve - NOT REMOVABLE

Accelerator Pump Removed

5. Remove primary, and secondary metering bodies from carburetor.

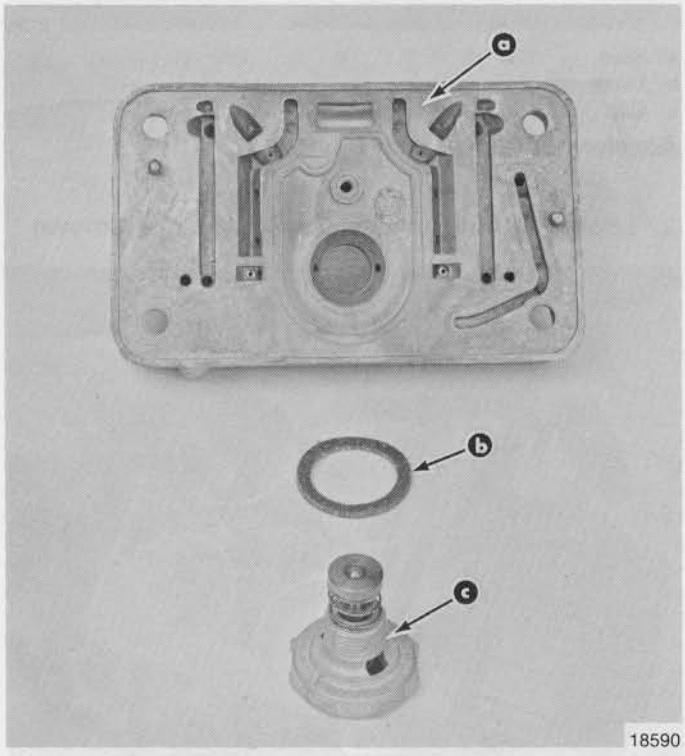


21173

a - Attaching Screws and Gaskets
b - Gaskets
c - Metering Body

Removing Metering Bodies

6. Remove power valves from both metering bodies. Power valve cannot be serviced separately, if defective it must be replaced.

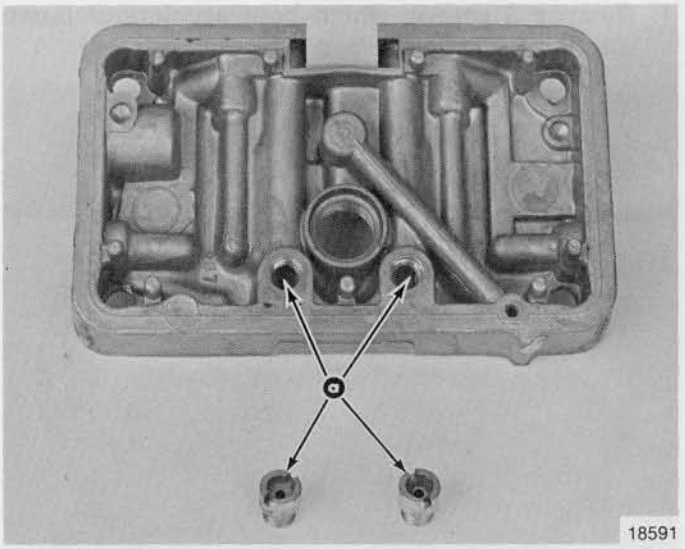


18590

a - Metering Body
b - Gasket
c - Power Valve

Power Valve Removed

7. Remove main fuel jets from metering bodies.



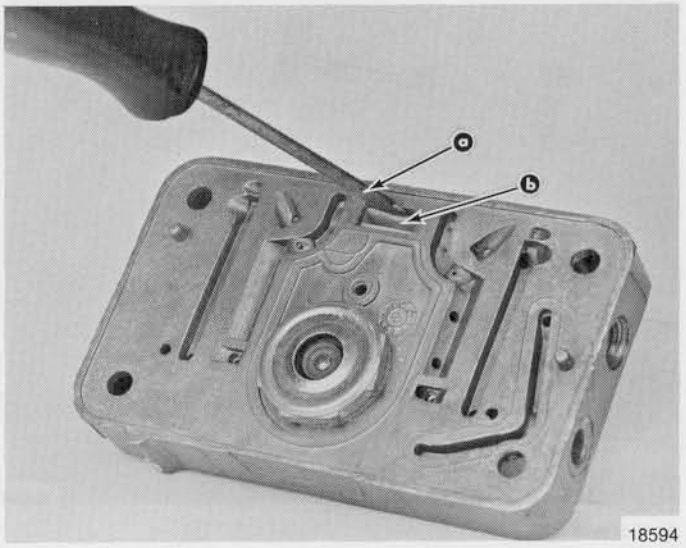
18591

a - Main Fuel Jets

Main Fuel Jets Removed

8. Remove float bowl vent tubes. Pry down on tip of vent tube with a small screwdriver and pull out. Vent tubes are held on place with small locating pin.

IMPORTANT: Locating pins should not be removed from metering bodies.



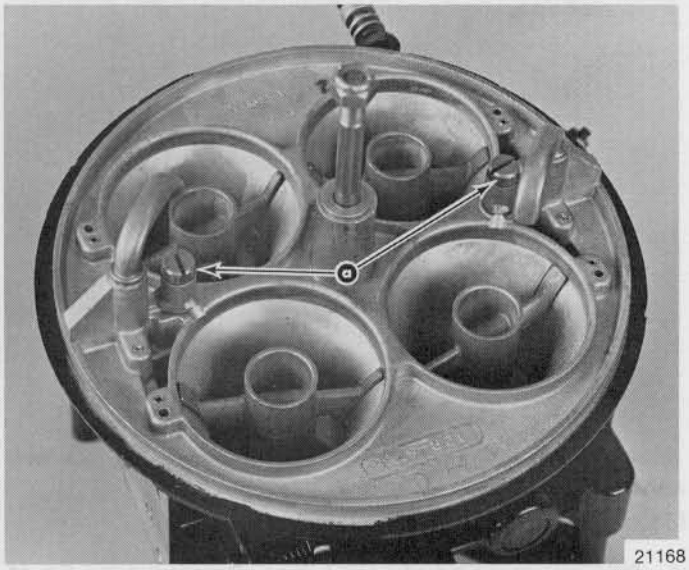
18594

a - Small Screwdriver
b - Float Bowl Vent Tube

Removing Float Bowl Vent Tubes

THROTTLE BODY

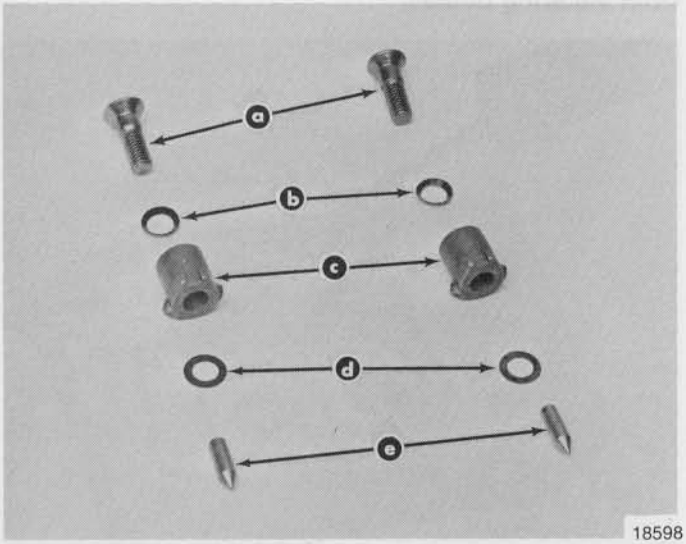
1. Remove 2 screws which hold accelerator pump discharge nozzle in place.



a - Screws

Accelerator Pump Discharge Nozzle Retaining Screws

2. Remove pump discharge nozzles and components.



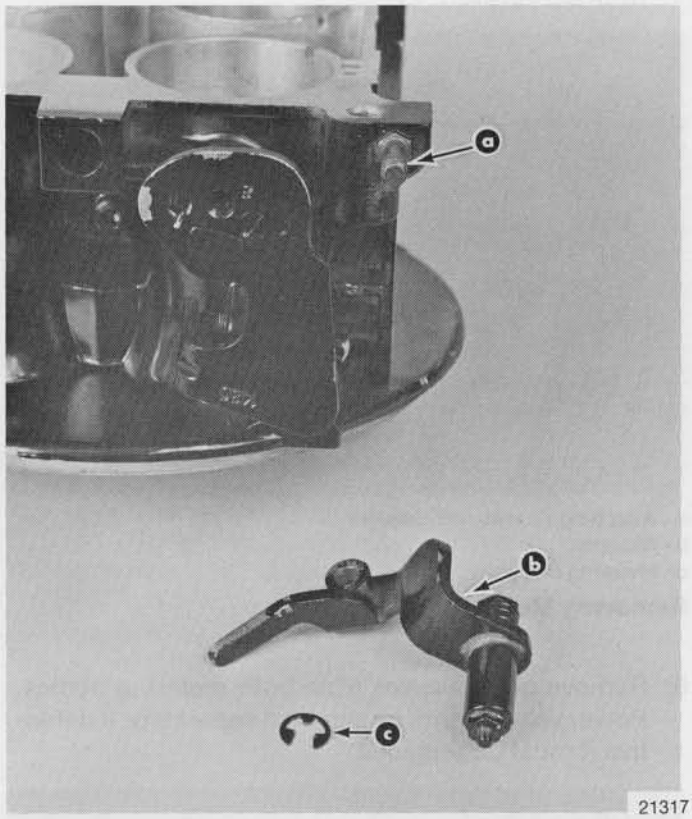
a - Screws
b - Gaskets
c - Nozzles
d - Gaskets
e - Needles

Pump Discharge Nozzles Removed

IMPORTANT: Further disassembly of the throttle body is normally not required, but if throttle body must be serviced, order parts from:

Holley Replacement Parts Division
11955 East Nine Mile Road
Warren, MI 48090

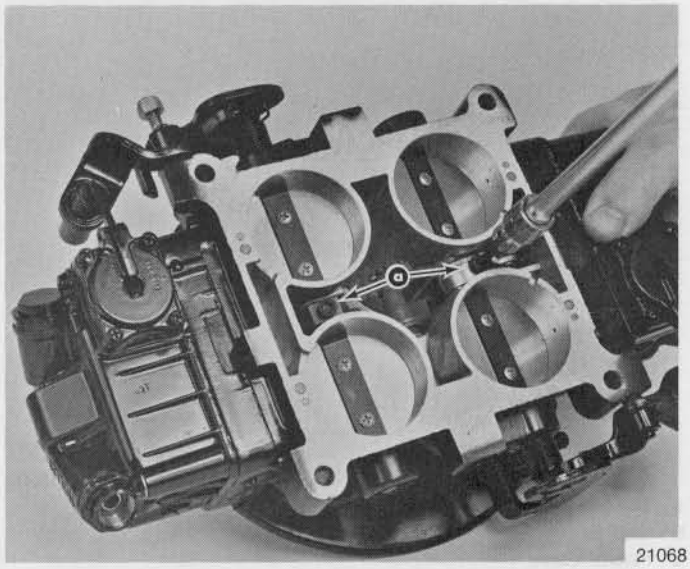
1. Remove accelerator pump levers.



a - Stud
b - Lever
c - Clip

Accelerator Pump Lever Removed

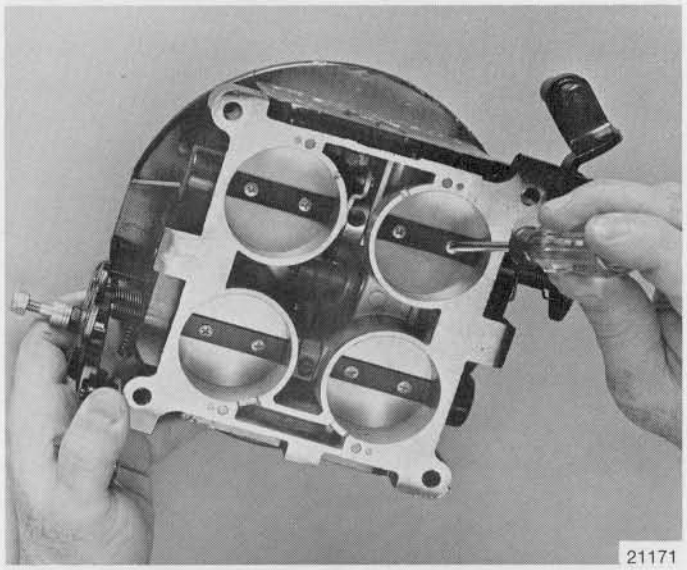
2. Loosen throttle linkage screws. (Do not remove).



a - Throttle Linkage Screws

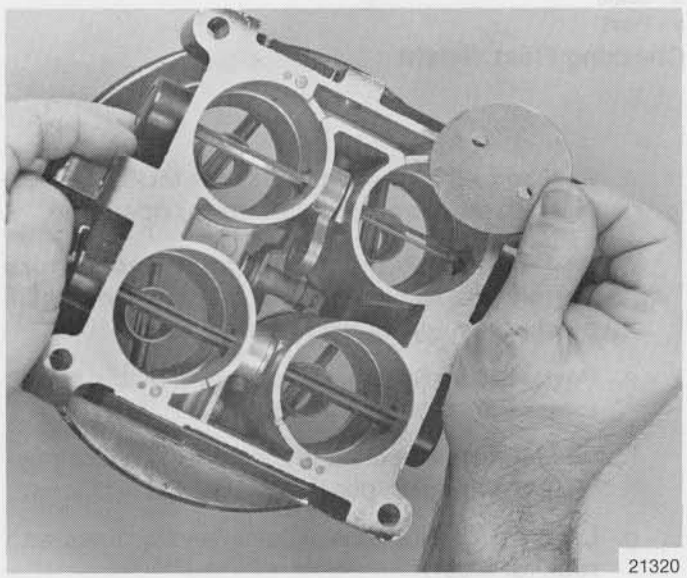
NOTE: Throttle plate screw ends must be filed flush with throttle shaft before removing.

3. Remove throttle plate screws.



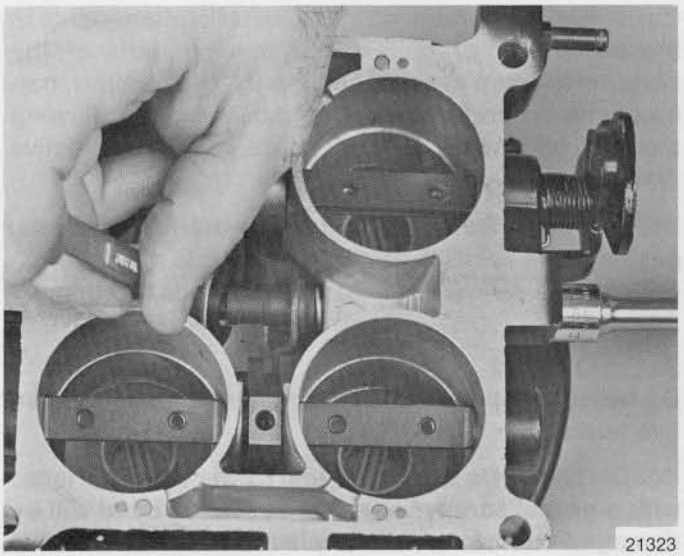
Removing Throttle Plate Screws

4. Actuate throttle to wide open position. Slide throttle plates out off throttle shafts.



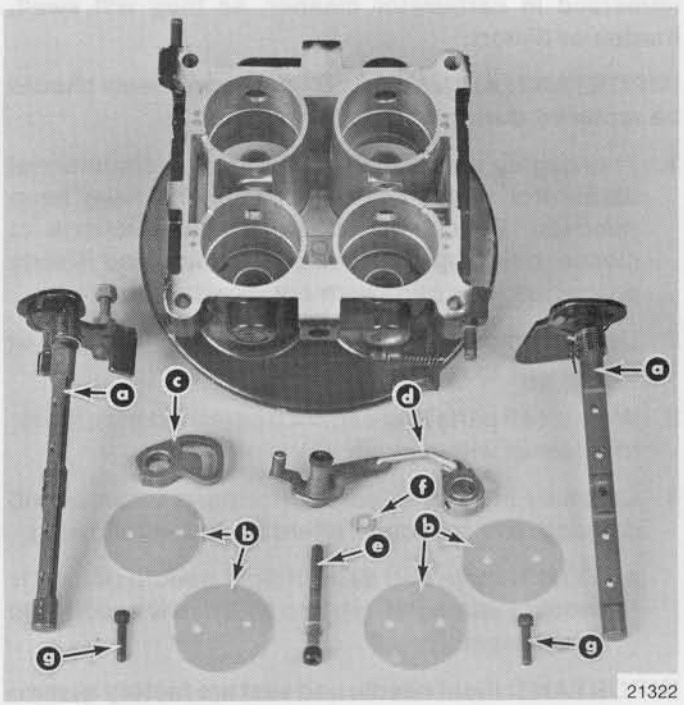
Removing Throttle Plates

5. Remove throttle linkage and pivot bracket screws.



Removing Pivot Bracket Screw

6. Remove throttle shafts and linkage.



a - Throttle Shafts
b - Throttle Plates
c - Primary Linkage
d - Pivot Arm and Secondary Linkage
e - Pivot Arm Screw and Flat Washer
f - Pivot Screw Lock Washer
g - Linkage Screws

Cleaning and Inspection

Carbon, varnish, gum, dirt, and water contaminants in the carburetor or on exterior moving parts of the carburetor often are responsible for carburetion malfunctions. Therefore, carefully observe the following cleaning and inspection procedure, to obtain effective carburetor repair.

IMPORTANT: Do not use a wire or drill to clean jets, passages, or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

⚠CAUTION

Do not leave carburetor in carb cleaner for more than two hours.

IMPORTANT: Do not clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and component replacement will be necessary.

⚠CAUTION

Any plastic, rubber, or neoprene parts should not be immersed in carburetor cleaner, as they will swell, harden or distort.

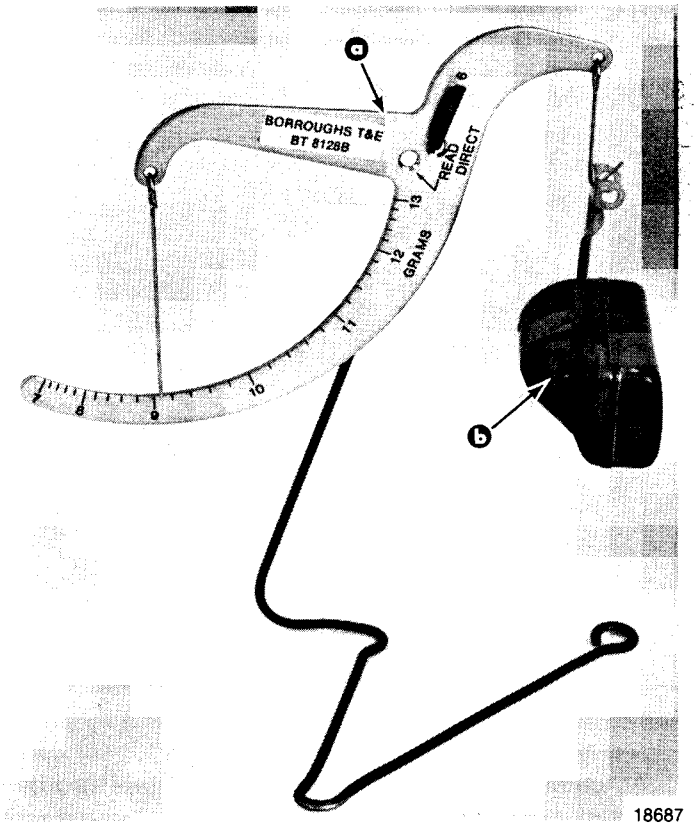
IMPORTANT: All gaskets, "O" rings, and seals should be replaced during carburetor repair.

1. Thoroughly clean all metal parts in a commercial carburetor cleaner, until all deposits have been removed. Follow manufacturer's instructions of cleaner being used for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage; pay particular attention to the following:

   a **Float Needle and Seat:** If float needle or seat is worn or damaged, replace with a new needle and seat assembly.

IMPORTANT: Float needle and seat are factory assembled. Needle and seat cannot be serviced separately.

   b. **Float Assembly and Hing Pin:** Inspect float pontoon for deterioration and porosity. Check pontoon density (to see if it is saturated with fuel), by comparing weight of float with specifications. If pontoon weight is high, float assembly MUST BE replaced. Shake float. If float contains fuel inside, float is leaking and must be replaced. Check hinge pin and holes for wear.



a - Scale
b - Float

Checking Float Weight

   c. **Fuel and Air Passages:** Passages MUST BE perfectly clean for proper carburetor operation.

   d. **Accelerator Pump Diaphragm and Return Spring:** Inspect pump diaphragm, check ball, discharge needles, and return spring.

   e. **Power Piston Spring:** Check power piston spring for weakness or distortion.

   f. **Idle Mixture Needles:** Inspect idle mixture needles. If damaged, needles MUST BE replaced.

   g. **Levers and Linkages:** Check levers, links and rods for wear.

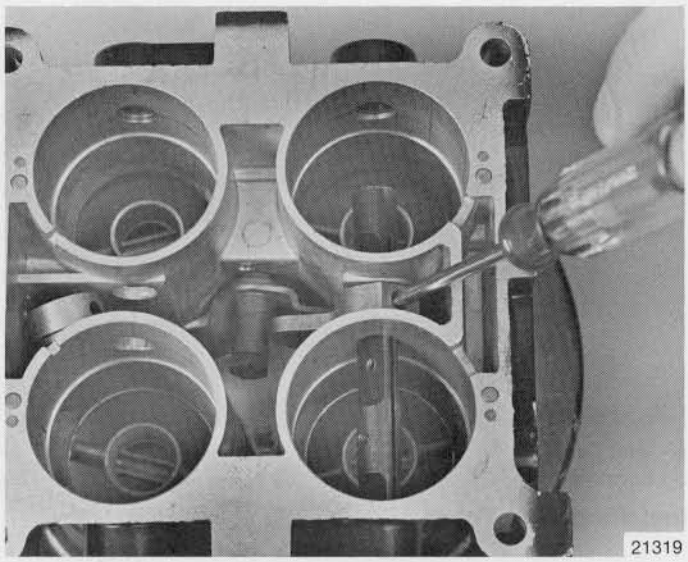
   h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Check throttle valve and shaft for binding thru entire operating range, making sure valve opens and closes completely. Throttle body assembly MUST BE replaced if throttle valve and shaft are worn or damaged.

   Inspect casting for visible damage. Inspect gasket surfaces.

Reassembly

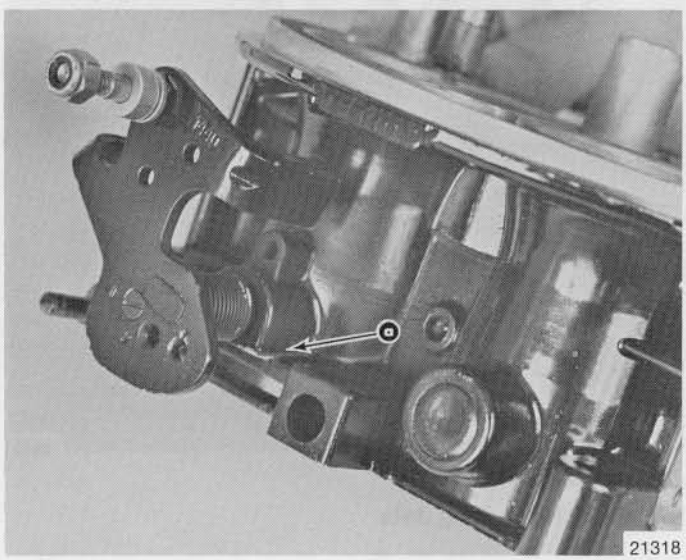
THROTTLE BODY

1. Install throttle linkage and throttle shaft.



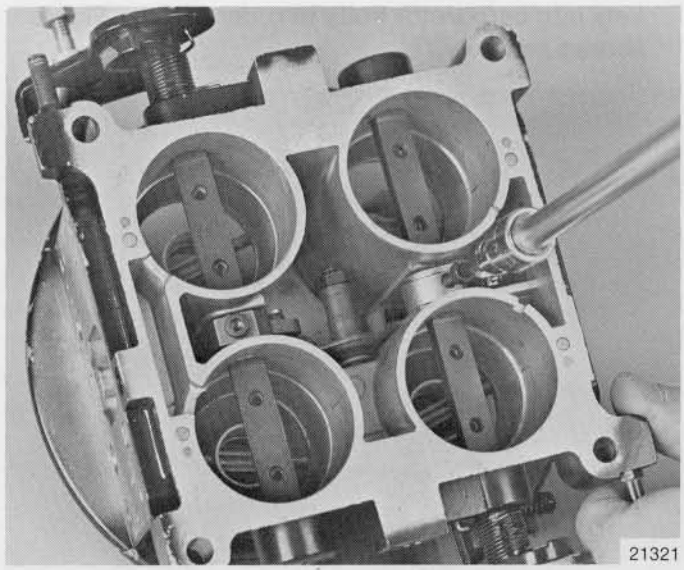
Installing Throttle Linkage and Shafts

IMPORTANT: Be sure throttle return spring is in correct location when installing throttle shafts.



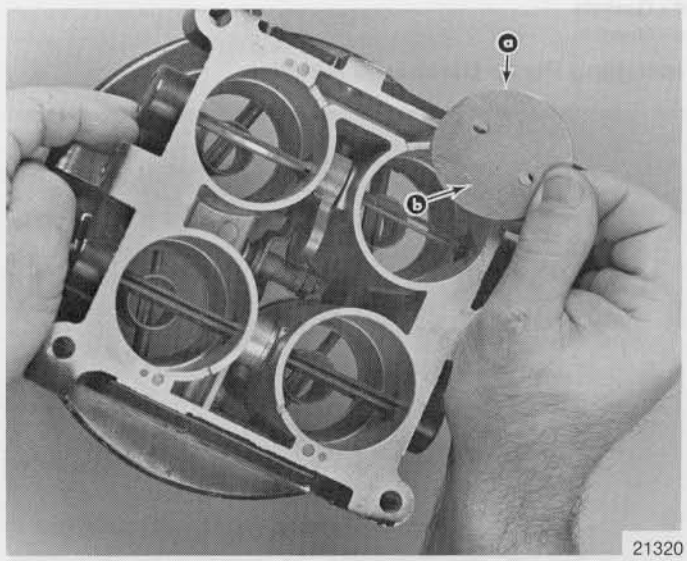
a - Throttle Return Spring Location

2. Install throttle linkage and pivot bracket screw. Do not tighten.



Installing Throttle Linkage Screws

3. Install throttle plate with stamped number facing toward metering plate and up toward Venturi.



a - Throttle Plate
b - Stamp Number

Installing Throttle Plates

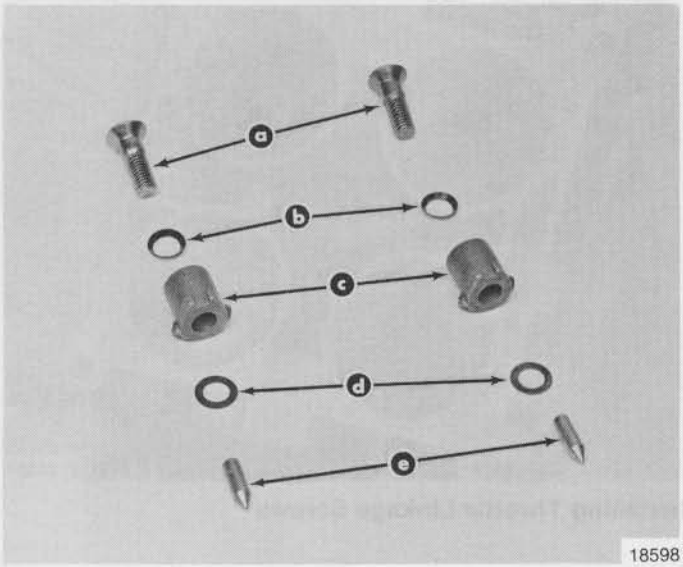
4. Install new throttle plate screws. Stake throttle plate screws through top of Venturi. Throttle shaft must be supported when staking screws.

⚠CAUTION
Improper installation of throttle plates, shafts and linkage could result in a sticking throttle causing uncontrolled engine speed or parts could loosen and enter engine.

5. Tighten all throttle linkage screws.
6. Install accelerator pump levers.

CARBURETOR BODY

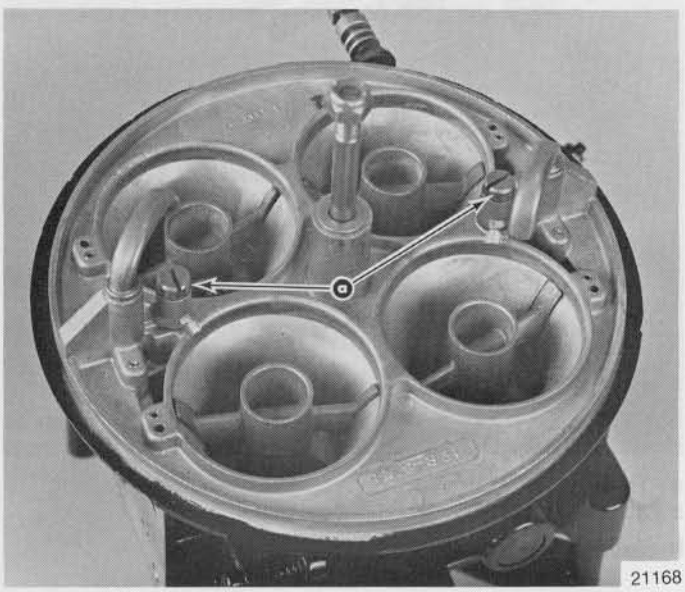
1. Install pump discharge nozzles, needles, and gaskets into carburetor body in order shown. Tighten screws securely.



18598

a - Screws
b - Gaskets
c - Nozzle
d - Gaskets
e - Needles

Installing Pump Discharge Needles



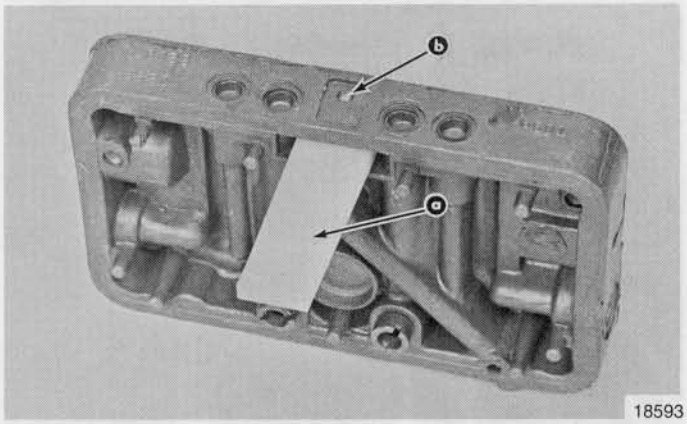
21168

a - Pump Discharge Needle Retaining Screws

Retaining Screws Installed

FUEL BOWLS and METERING BODIES

1. Install fuel bowl vent tubes into metering bodies, vent tube must be pushed in far enough to lock into locating pin.

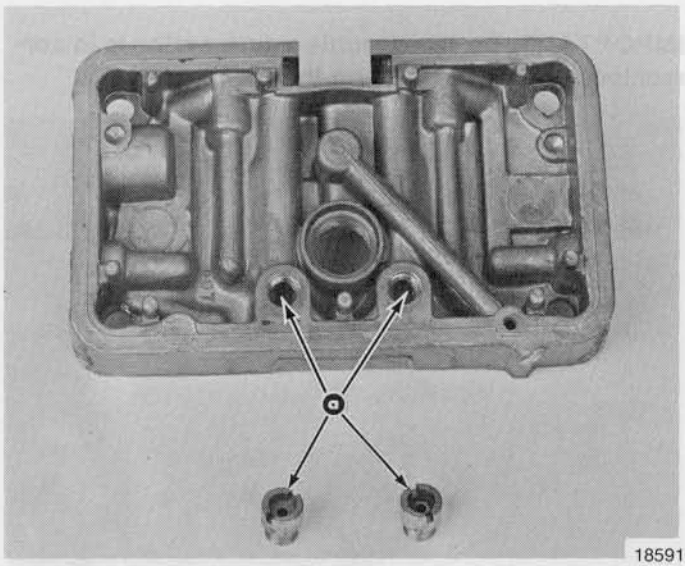


18593

a - Vent Tube
b - Locating Pin

Installing Vent Tubes

2. Install primary and secondary main fuel jets.

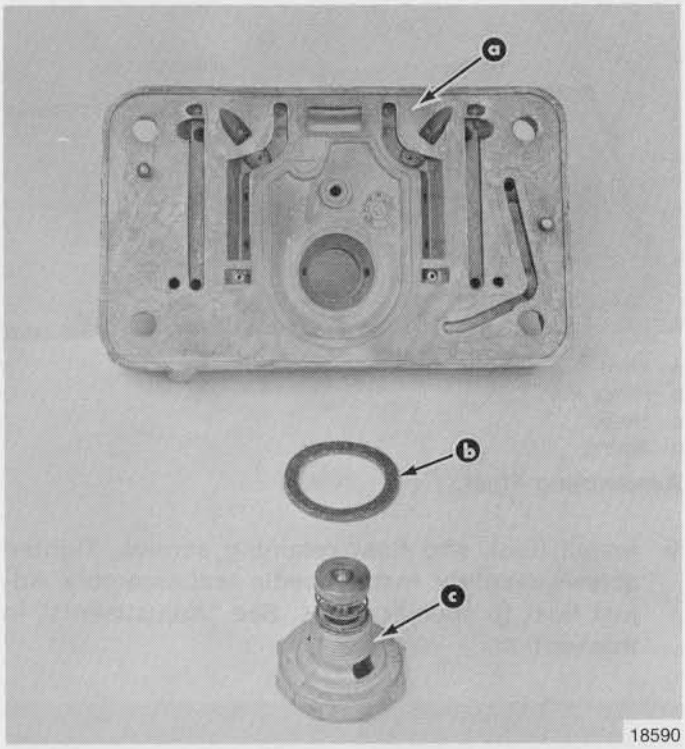


18591

a - Main Fuel Jets

Installing Main Fuel Jets

3. Install power valve and new gasket in primary metering body.

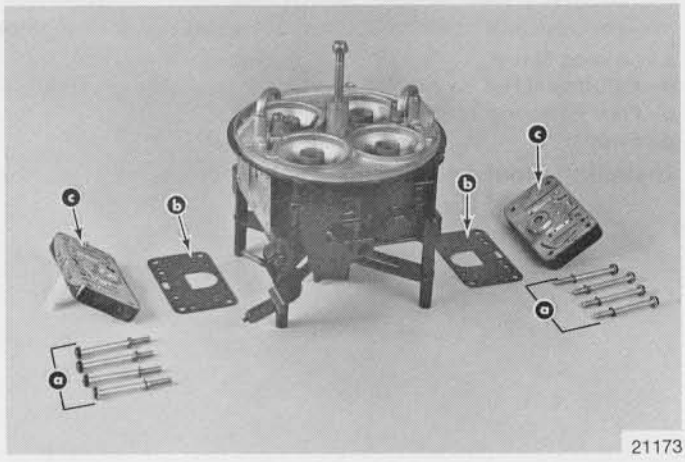


a - Primary Metering Body
b - Gasket
c - Power Valve

Installing Power Valve

4. Assembly metering bodies to carburetor body in order shown.

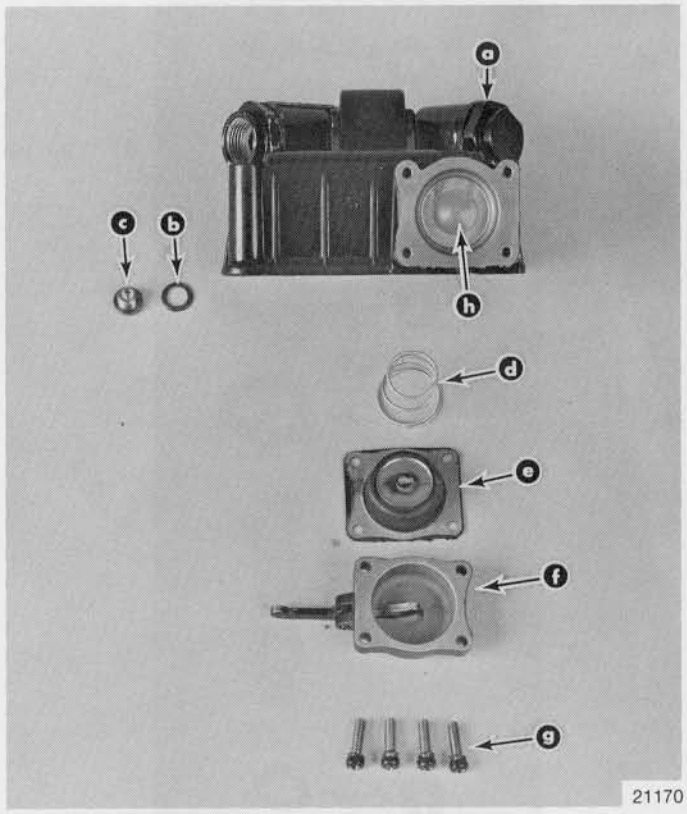
IMPORTANT: On 440/460 Cyclone carburetors this operation cannot be performed until fuel bowls are assembled because the carburetor has through bolts in place of the springs.



a - Attaching Screws and Gasket
b - Gasket
c - Metering Body

Installing Metering Bodies

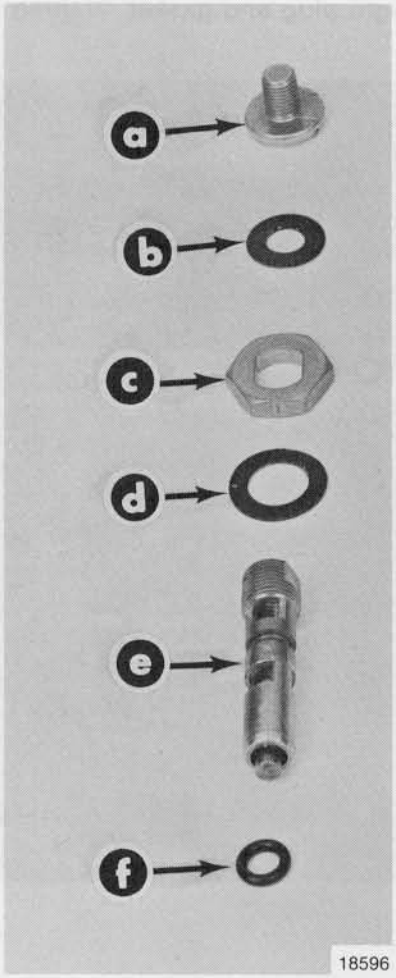
5. Install accelerator pump assembly as shown.
6. Install sight plug and gasket. Tighten screws securely.



a - Fuel Bowl
b - Gasket
c - Sight Plug
d - Spring
e - Diaphragm
f - Pump Housing
g - Screws
h - Check Valve

Installing Accelerator Pump

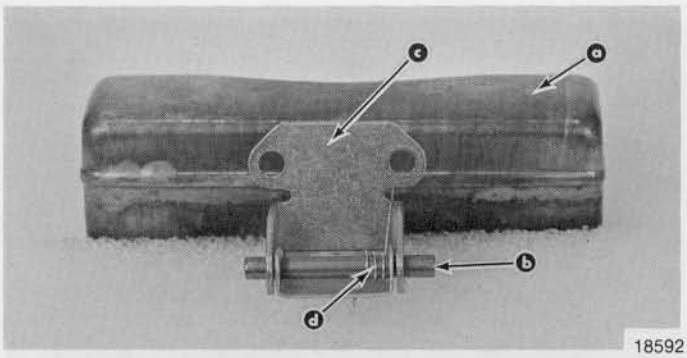
7. Assemble needle seat as shown.



a - Locking Screw
b - Gasket
c - Adjustment Nut
d - Gasket
e - Needle Seat Assembly
f - "O" Ring

Needle Seat Assembly

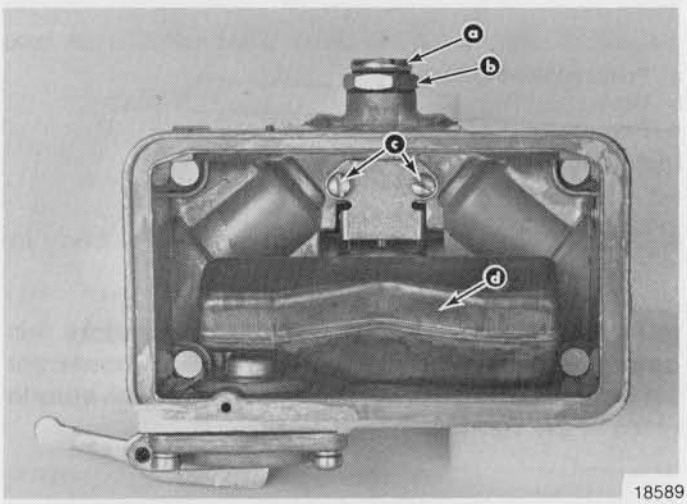
8. Assemble float, spring, hinge, and hinge pin as shown.



a - Float
b - Hinge Pin
c - Hinge
d - Spring

Assembling Float

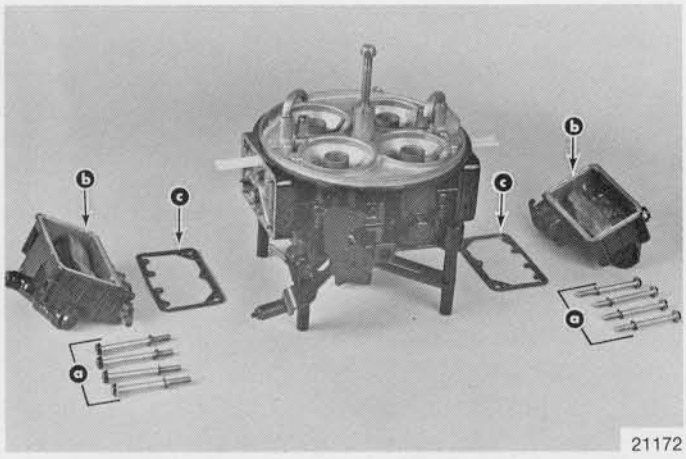
9. Install float, and float retaining screws. Tighten screws securely. Install needle seat assembly. Adjust float to specifications. See "Adjustments" in this section.



a - Locking Screw
b - Adjustment Nut
c - Float Retaining Screws
d - Float

Installing Float and Needle Seat

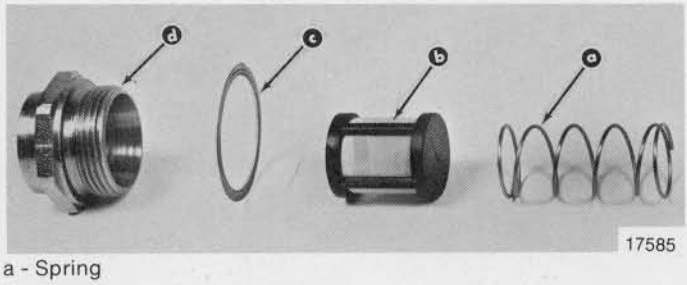
10. Install fuel bowls as shown. Tighten screws securely.



a - Screw and Gaskets
b - Fuel Bowl
c - Fuel Bowl Gasket

Installing Fuel Bowls

11. Install fuel inlet filter components, fuel inlet gasket, and nut as shown. Tighten nut securely.

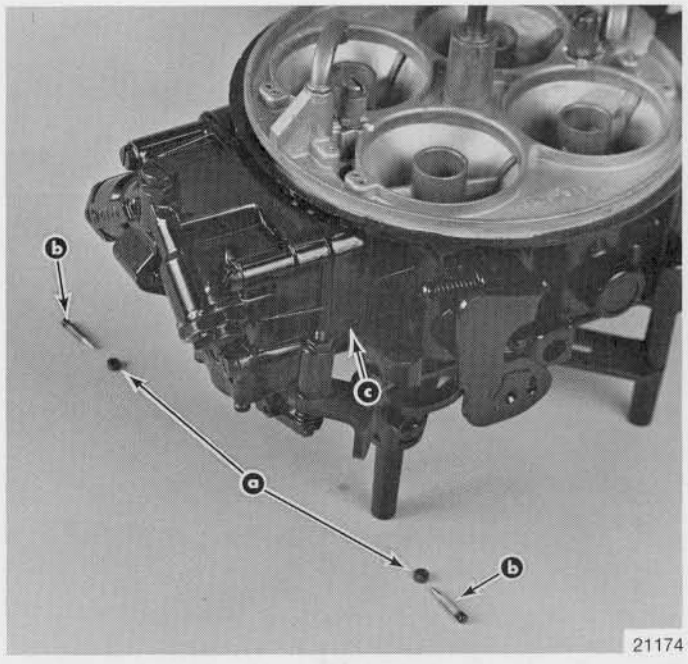


a - Spring
b - Filter (Open End Towards Nut)
c - Gasket
d - Fuel Inlet Nut

Installing Filter and Inlet Nut

12. Install idle mixture screws and gaskets. Lightly seat needles, then back out 1-1/4 turns.

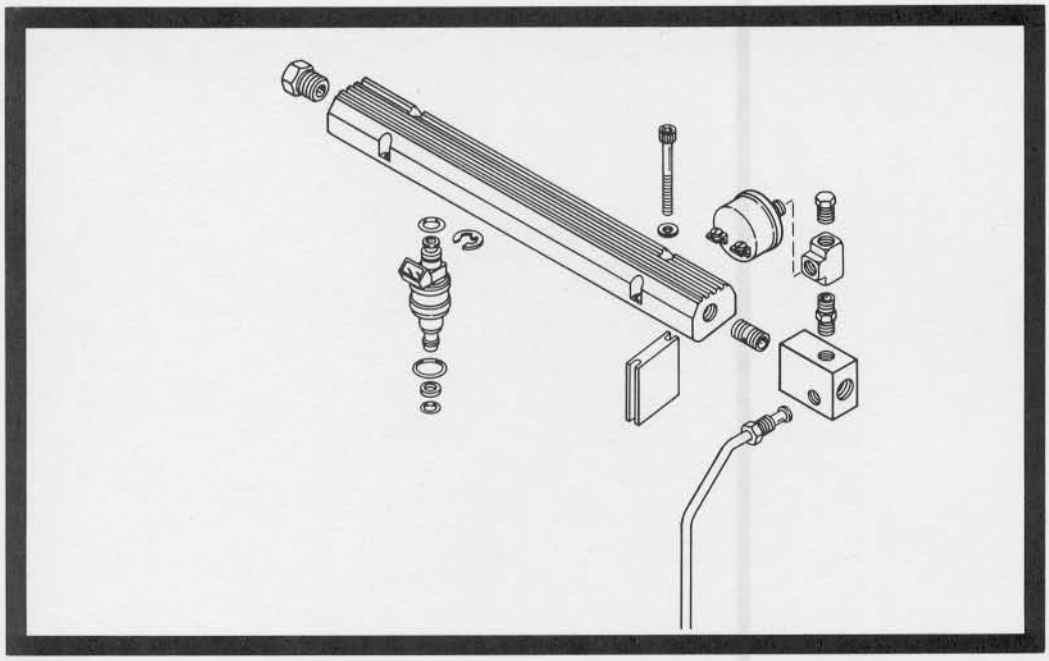
IMPORTANT: Do not tighten idle mixture needles against seats or damage to needle and/or seat may result.



a - Gaskets
b - Needles
c - Idle Mixture Hole (Only One Shown)

Installing Idle Mixture Screws

FUEL SYSTEM



FUEL INJECTORS/FUEL RAILS

5

F

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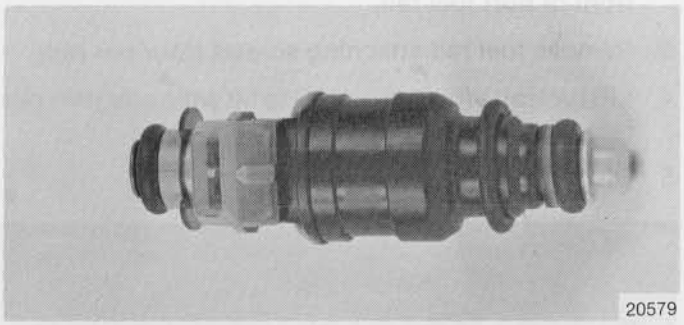
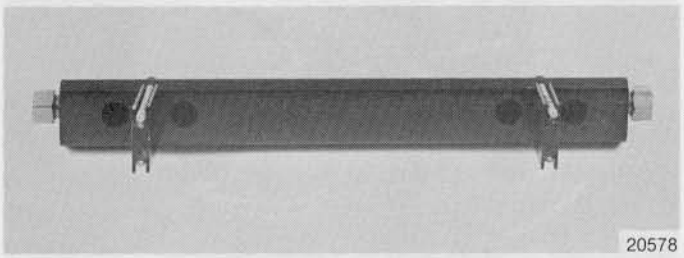
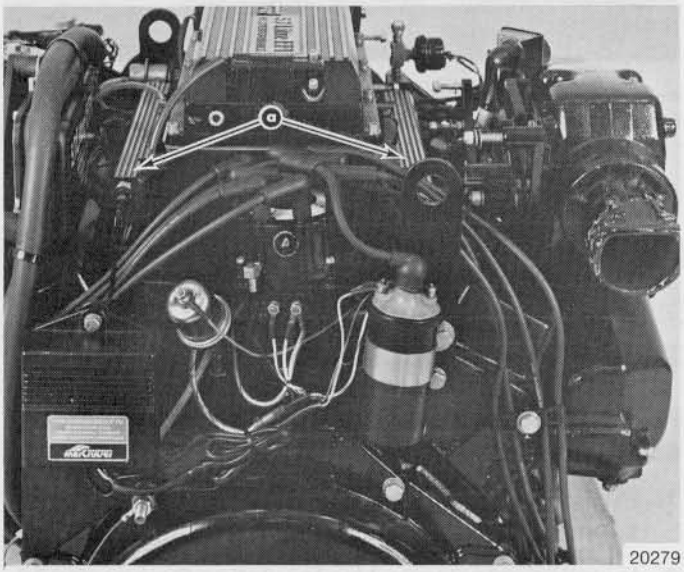
Identification



Fuel Injector



Fuel Rail



a - Fuel Rails, Injectors (Four Per Rail) Between Manifold and Rail

Fuel Rail/Injector Location on Engine

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do no comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Fuel Fitting to Rail	*10-18 (14-25)	
Cross Over Fuel Line to Fuel Fitting	Securely	
Inlet Fuel Line to Fuel Block	Securely	
Return Fuel Lines	Securely	
Fuel Regulator	Securely	
Fuel Rail		30 (3)

*NOTE 1: Coat fuel line inlet and outlet fitting threads with Loctite Pipe Sealant with Teflon, DO NOT use Teflon tape. Torque to specifications.

Lubricants/Sealants

LUBRICANTS/SEALANTS	
92-41669-1	Quicksilver Insulating Compound
92-13831	Quicksilver 4 Cycle Lubricant

SEALANTS OBTAINED LOCALLY
Loctite Pipe Sealant with Teflon

Precautions

⚠WARNING
ALWAYS disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

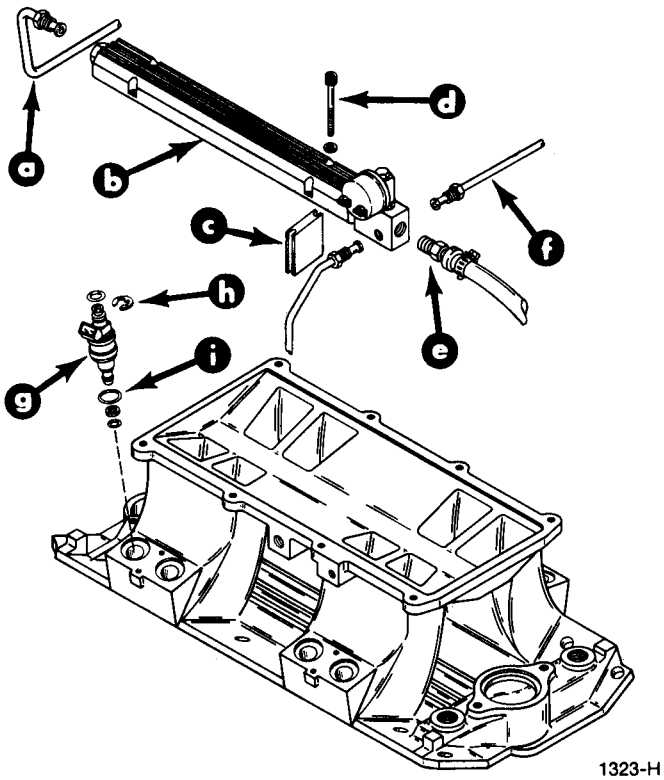
⚠WARNING
Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filters. Wipe up any spilled fuel immediately.

⚠WARNING
Make sure that no fuel leaks exist, before closing engine hatch.

⚠CAUTION
DO NOT operate engine without cooling water being supplied to seawater pickup pump or pump impeller will be damaged, and subsequent overheating damage may result.

Injector/Fuel Rail Removal

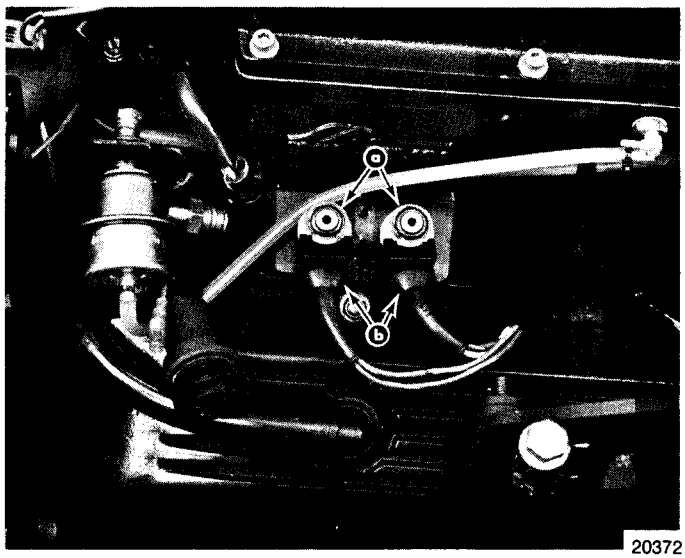
1. Disconnect cross over fuel line from rear of fuel rail.



1323-H

a - Crossover Fuel Line
b - Fuel Rail
c - Support
d - Screw and Washer
e - Inlet Fuel Line
f - Return Fuel Line
g - Fuel Injector
h - E-Clip
i - O-Ring (Injector to Manifold)

2. Disconnect return lines and fuel inlet hose from front starboard fuel rail and/or fuel regulator from front of port fuel rail.
3. Remove fuel rail attaching screws (four per rail).
4. Lift fuel rail off injectors, try to lift supports (two per rail) with fuel rail.
5. Disconnect injector lead.



20372

a - Injector (Installed into Manifold)
b - Injector Lead

6. Pull injector from manifold.

NOTE: If injector is being replaced, E-ring and O-ring (manifold base to injector base) must be reused.

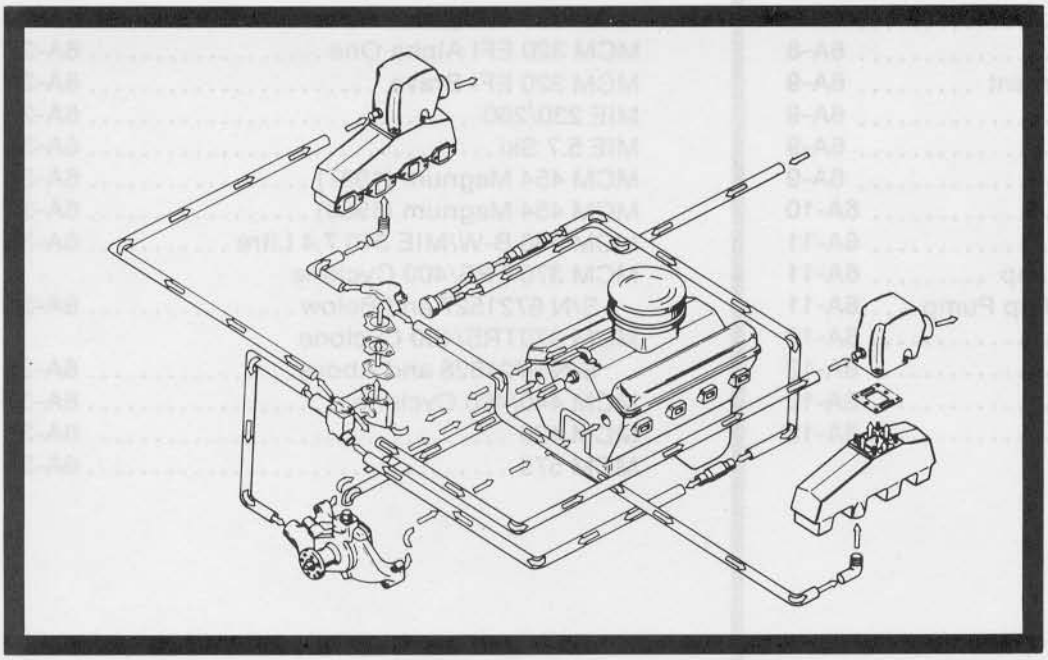
Injector/Fuel Rail Installation

NOTE: Upper and lower injector o-rings must be lubricated with engine oil to prevent o-rings from galling.

1. Push injector into manifold bore. Check o-ring alignment.
2. Install injector leads. Use Insulating Compound 92-41669-1.
3. Align injector tops with fuel rail openings and push rail onto injectors.
4. Install fuel rail screws. Torque to 30 lb. in. (3 N.m).
5. Install fuel lines and regulator, tighten securely.

NOTE: Run fuel pump approximately one minute to bleed air from fuel system before starting.

COOLING SYSTEM



SEAWATER COOLED MODELS

6

A

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Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace to Alternator		192 (28)
Alternator Brace to Block	30 (41)	
Alternator to Mounting Bracket	35 (48)	
Alternator Mounting Bracket	30 (41)	
Drain Plugs (Note 1)	Securely	
Petcocks	Securely	
Power Steering Pump Brace to Block	30 (41)	
Power Steering Pump Bracket	30 (41)	
Pulleys	Securely	
Seawater Pump Brace	30 (41)	
Seawater Pump Bracket to Block	30 (41)	
Seawater Pump Clamping Screw on Cast Bracket	20 (27)	
Seawater Pump Cover		120 (14)
Seawater Pump Mounting Nuts to Stamped Steel Bracket		120 (14)
Hose Clamps	Securely	
Thermostat Cover	30 (41)	
Thermostat Housing	30 (41)	
Thru-Hull Pickup Nut	35 (42)	
Water Circulating Pump	30 (41)	
Water Temp. Sender	20 (27)	

NOTE 1. Coat threads with Perfect Seal before installing.

Tools/Lubricants/Sealants

TOOLS/LUBRICANTS/SEALANTS	
91-37241	Universal Puller Plate
92-32609-1	Quicksilver Loctite (A)
92-34227-1	Quicksilver Perfect Seal
92-86154A1	Quicksilver 2-4-C Marine Lubricant
92-79214A1	Quicksilver Special Lubricant 101
73971A2	Flush Device

LUBRICANT OBTAINED LOCALLY
Shell Alvania No. 2

Specifications

COOLING SYSTEM CAPACITY	
Model	**Qts (litres) Approximately**
MCM 200/230/260 MCM 300 Tempest MCM 350 Magnum MCM 5.7 Ski MIE 230/260	15 (14.1)
MCM 330 B-W MCM 454 Magnum MIE 340 MCM 370 MCM 400/ 440/460 Cyclone	20 (18.9)

THERMOSTAT	
All Models	143° F (62° C)

Seawater Inlet Recommendations

Transom Mounted or Thru-Hull Seawater Pickups and Hose

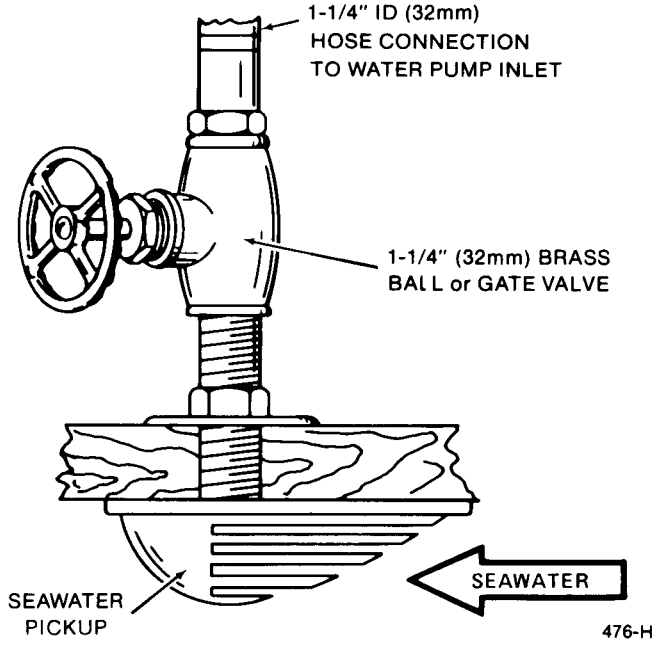
Water pickup must be large enough to permit sufficient water flow to engine seawater pickup pump for adequate engine cooling [30 gal. per min. (114 litres per min.) minimum]. Pickup also must supply a positive head while underway.

⚠CAUTION
Do not install water pickup directly in line with propeller, as pickup may create turbulence and allow air to flow into the "propeller slipstream". This will cause propeller ventilation and will adversely affect boat performance.

Water pickup should be located as close to seawater pickup pump inlet as possible and in an area where an uninterrupted, solid stream of water will flow past when boat is underway. Connect water pickup to seawater pickup pump inlet with 1-1/4" (32mm) ID wire reinforced hose of adequate wall thickness to prevent it from collapsing from pump suction. Be sure to secure hose connections with hose clamps.

Seawater Inlet Valve

If a seawater inlet valve is being used, it must be installed between water pickup and seawater pickup pump (or sea strainer), to allow operator to shut off the seawater in case of a leak or when boat is not in use. This will allow the operator to flush or drain the engine, or clean the sea strainer while boat is in the water. Valve used must have an internal cross-sectional area equal to or greater than hose to prevent restricting water flow. Install valve in an area where it will be easily accessible and support adequately to prevent hose fatigue.



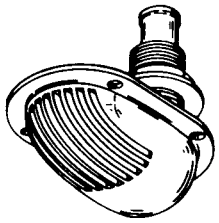
Seawater Inlet Valve (Thru-Hull Pickup Shown)

Sea Strainer

If boat is equipped with a sea strainer, it must be of sufficient size to ensure that an adequate supply of water is maintained for engine cooling. Install seawater strainer in an area where it will be easily accessible for inspection and cleaning. Strainer should be installed in water inlet hose after water inlet valve to allow operator to shut off water when cleaning strainer.

Seawater Pickups

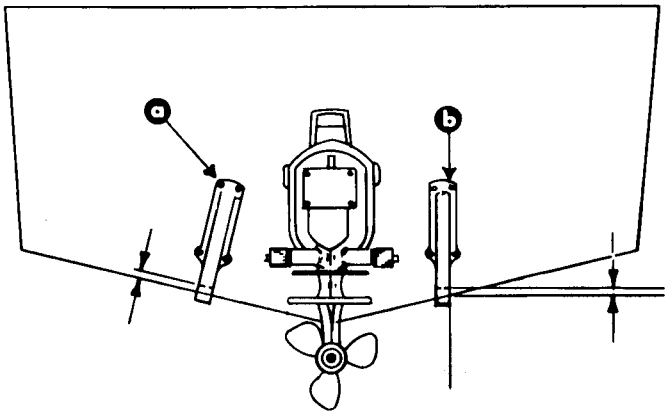
Thru-Hull



Thru-Hull

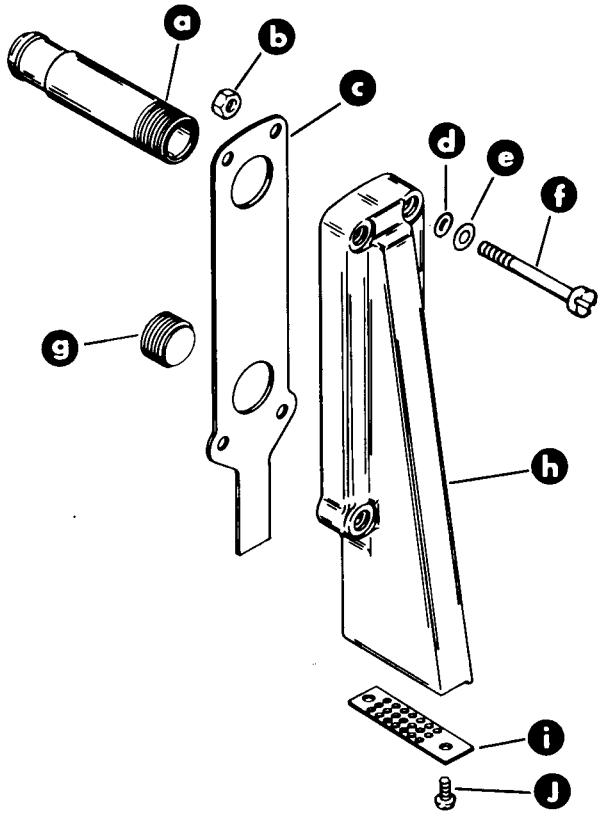
1. Install pickup through 1-3/4" (44mm) hole in hull. The slots must be facing forward and parallel with flow of water.
2. Fasten pickup with the four (4) mounting screws. Apply Loctite to threads and install nut on pickup on inside of boat and torque nut to specifications.

Transom Mounted



a - Diagonal Mount [Leading Edge Of Pickup 1/8" (3.2mm) from Boat Bottom]
b - Vertical Mount [Corner of Leading Edge of Pickup 1/8" (3.2mm) from Boat Bottom]

Water Pickup Installed on Transom



a - Hose Nipple - Pipe Thread Sealer on Threads, Tighten Securely
b - Nuts (4) Tighten Securely
c - Gasket - Between Pickup and Transom
d - "O" Ring (4)
e - Washer (4)
f - Screw (4) - Coat Each Shaft With Silicone Sealant or Equivalant
g - Plastic Plug - Teflon Paste to Threads, Tighten Securely
h - Pickup
i - Screen
j - Screw (2) - Tighten Securely

Seawater Pickup Installation

Seawater Pickup Pump Output Test

If an overheating problem exists, use this test to determine if a sufficient amount of water is being supplied to cool engine.

IMPORTANT: The following information should be observed before proceeding with test:

- **BOAT MUST BE IN THE WATER FOR THIS TEST. This test CANNOT BE performed with a flush-test device and a water hose.**
- **The ability of this test to detect a problem is greatly dependent upon the accuracy in which it is performed. An error in setting the engine RPM, timing the test or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results, a shop tachometer with an error of less than 5% should be used. The boat tachometer definitely should not be used as its accuracy is questionable. A stop watch should be used to time the duration of the test to help ensure that the accuracy is maintained within 1 second. A 8 quart (7.6 litre) or larger capacity container calibrated in 1/4 quart increments should be used to measure water output.**
- **Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem.**

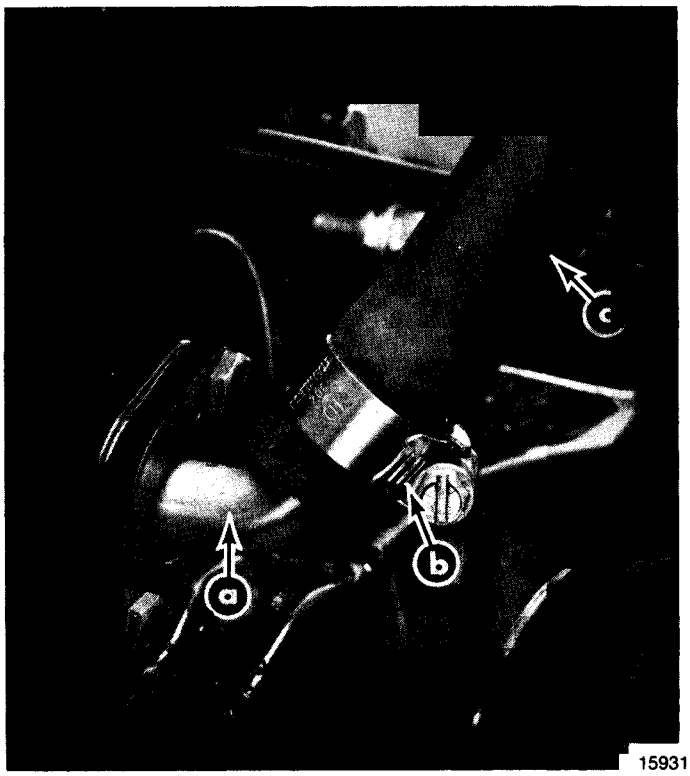
1. **Stern Drive Seawater Pickup Pump Models:** Remove water inlet hose, which runs between gimbal housing water tube and engine, and replace with another hose of same diameter, but approximately 3 ft. (1m) longer. Hose should be wire reinforced or of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at gimbal housing water tube only. Do not clamp hose at engine end.

   Belt Driven Seawater Pickup Pump: Remove water hose, which runs between pump outlet and engine and replace with another hose of same diameter, but approximately 3 ft. (1m) longer. Hose should be wire reinforced or of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at pump outlet only. Do not clamp hose at engine end.

2. Place an 8 quart (7.6 litres) or larger container near unclamped end of hose.

⚠CAUTION

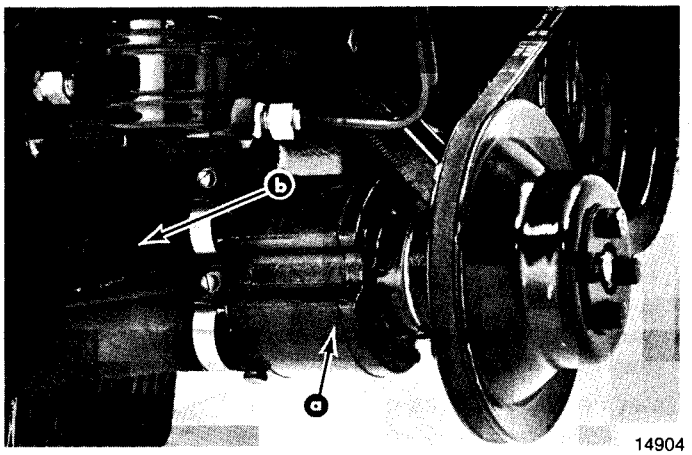
Do not run engine for more than 15 seconds with hose disconnected, in next step, as internal damage to engine and exhaust system may result.



15931

a - Water Tube
b - Hose Clamp
c - Water Hose

Stern Drive Pump Models



14904

a - Seawater Pickup Pump
b - Seawater Outlet Hose

Belt Driven Pump Models

3. With assistance of another person, start engine and adjust speed to exactly 1000 RPM, while holding unclamped end of hose on connection on engine. Remove hose from connection on engine and direct water flow into container for exactly 15 seconds. At the end of 15 seconds, direct the water flow overboard, return engine to idle and stop engine. Reconnect hose to engine.
4. Measure quantity of water discharged into container and compare with specifications given in chart below.
5. Repeat test 4 times to check repeatability of results.

STERN DRIVE PUMP OUTPUT FOR 15 SECOND PERIOD	
Drive Unit Gear Ratio	**Minimum Quantity**
1.98:1	3.0 Qts. (2.8 litres)
1.84:1	3.3 Qts. (3.1 litres)
1.65:1	3.6 Qts. (3.4 litres)
1.50:1	4.0 Qts. (3.8 litres)
1.32:1	4.5 Qts. (4.3 litres)

BELT DRIVEN PUMP OUTPUT FOR 15 SECOND PERIOD
7.5 Qts. (7.1 litres) Minimum

Stern Drive Unit Seawater Pickup Pump

NOTICE
MCM 200/230/260/300 Tempest TRS/350 Magnum/454 Magnum have a seawater pickup pump mounted in stern drive unit. Refer to "Stern Drive Service Manual" for repairs.

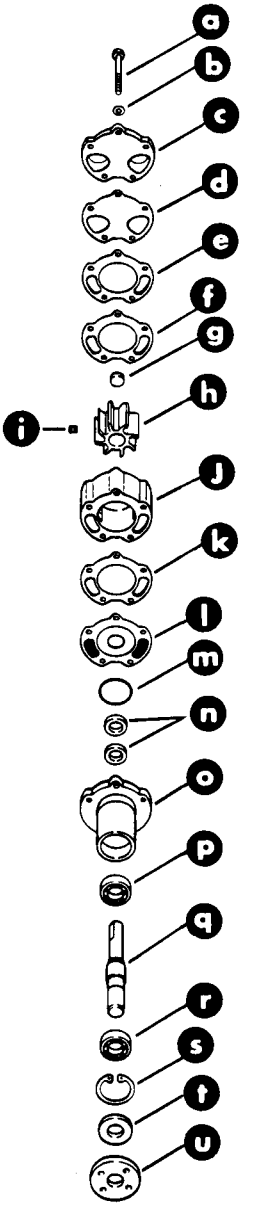
Belt Driven Seawater Pickup Pump

Removal

⚠CAUTION
If boat is in the water, be sure to close water inlet valve before removing inlet hose from pump to prevent water from draining into boat. If boat is not fitted with a valve, either plug inlet or raise it above water level after removing.

IMPORTANT: The following procedure describes removal of both pump and mounting bracket from engine. On some installations, however, it may be possible to remove pump with mounting bracket left installed on engine.

1. Disconnect water inlet and outlet hoses from pump.
2. If pump is to be disassembled, break loose 4 pump pulley attaching screws. Do not remove screws at this time.
3. **On Engines With Power Steering:** Remove Power Steering pump drive belt to allow removal of seawater pickup pump drive belt. (Some models)
4. Remove pulley attaching screws and clamping ring (some models) then remove pulley.
5. Remove attaching hardware which secures pump brace to cylinder block, oil pan or Power Steering pump (as applicable).
6. Remove pump mounting bracket-to-cylinder block attaching hardware and remove pump, mounting bracket and brace as an assembly.
7. Loosen clamping screw, then remove pump. It may be necessary to spread clamping bosses.



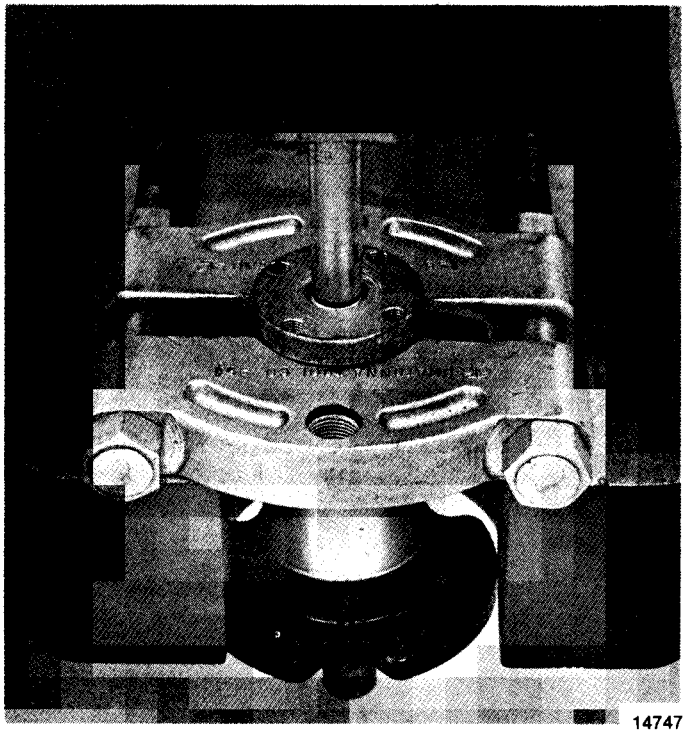
a - Screw (5)
b - Washer (5)
c - Cover
d - Gasket
e - Wear Plate (Outer)
f - Gasket
g - Plug
h - Impeller
i - Key
j - Body
k - Gasket
l - Wear Plate (Inner)
m - "O" Ring or Quad Ring
n - Oil Seal
o - Housing
p - Ball Bearing
q - Shaft
r - Ball Bearing
s - Snap ring
t - Oil Seal
u - Hub

Pump Assembly

Disassembly

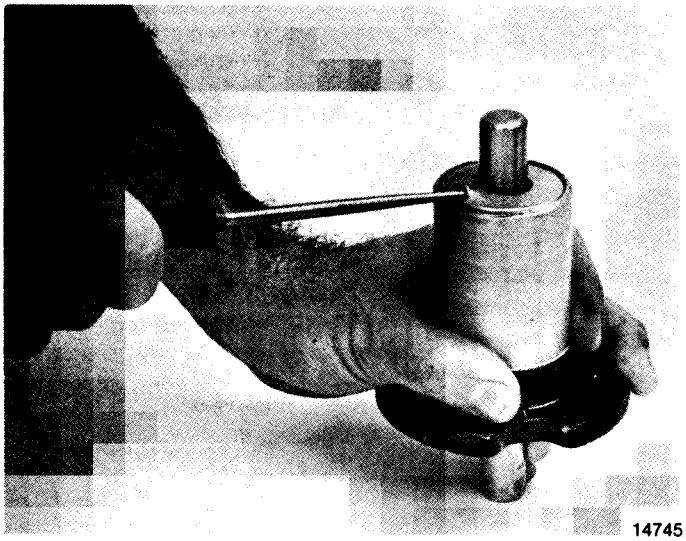
1. Remove cover and body attaching screws and washers. Remove cover, gasket, outer wear plate and gasket. (Discard gaskets.)
2. Slide pump body off shaft. Remove impeller from pump body and rubber plug from impeller.

3. Remove impeller drive key from pump shaft, then remove gasket, inner wear plate and "O" ring (or Quad Ring). Discard gasket and "O" ring (or Quad Ring).
4. Press hub off shaft with Universal Puller Plate (91-37241) and an arbor press.


14747

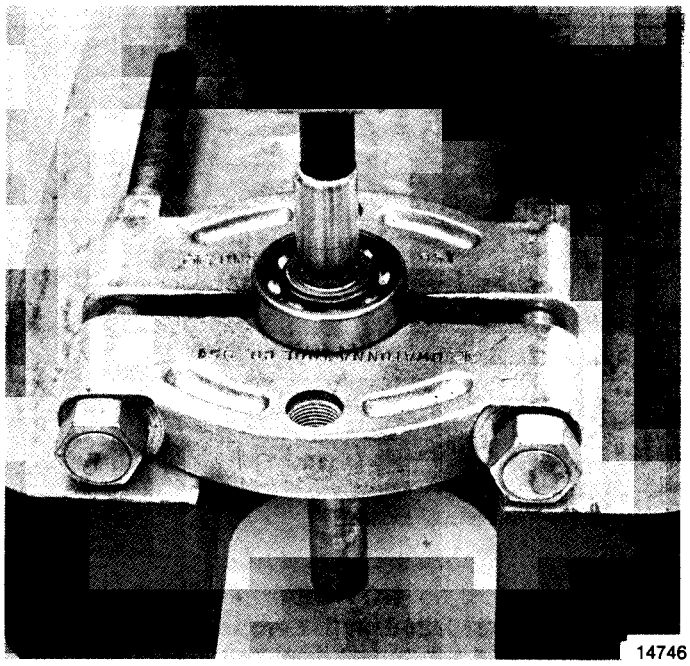
Removing Hub

5. Puncture front oil seal with a tool and pry from bearing housing.


14745

Removing Front Oil Seal

6. Remove snap ring from bearing housing bore and press shaft and bearings out pulley end of housing. Bearings have a slip fit in housing, do not use excessive force.
7. If bearings require replacement, remove bearings from shaft with Universal Puller Plate and an arbor press. Bearings must be replaced, if removed.


14746

Removing Bearings from Pump Shaft

8. If rear seals require replacement, press seals from bearing housing with an appropriate tool.

Cleaning and Inspection

1. Clean metal parts in solvent and blow dry with compressed air.

IMPORTANT: Do not spin bearings at high speed when drying with compressed air, as bearings may be scored.

2. After cleaning, apply a coat of light engine oil to shaft and bearings to prevent rust.
3. Clean all gasket material and sealer from sealing surfaces.
4. Inspect bearing housing. Examine surfaces (where bearings contact housing) for evidence of bearing outer races turning in housing.
5. Inspect seals in bearing housing.
6. Inspect pump shaft bearings.
7. Inspect pump shaft for grooves in surface where seals contact shaft. Inspect keyway in shaft. Also, inspect surface, where bearings contact shaft, for evidence of inner races turning on shaft.
8. Inspect impeller drive key.
9. Inspect pump body.
10. Inspect inner and outer wear plate.

11. Inspect pump impeller for wear on sides and tips of blades. Also inspect blades for cracks in area where blades flex. Replace impeller, if blades have taken a set (remain in curved position).
12. Inspect pump pulley.
13. Check drive belt for excessive wear.

Reassembly

Refer to Figure 1 also.

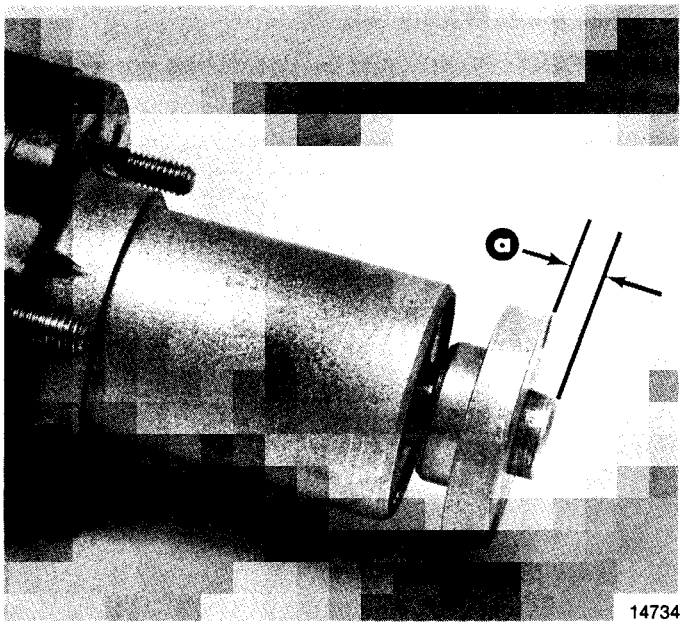
1. Apply a thin coat of Loctite Type 'A" to outside diameter of 2 new bearing housing rear seals, then install seals in housing with seal lips facing impeller end. (Press first seal in until it bottoms-out and second seal in until flush with housing.)

IMPORTANT: It is recommended that Shell Alvanina No. 2 Grease be used when packing seal and bearings in the following steps. If Shell Alvania No. 2 Grease is not available, it is permissable to use 2-4-C Marine Lubricant. However, 2-4-C Marine Lubricant is not recommended for applications where continuous high speed heavy-duty operation will be encountered.

2. Pack cavity between seals with Shell Alvania No.2 Grease or substitute.
3. Using an arbor press and suitable tool, press ball bearings onto shaft until they seat. Press on inner race of bearing only.
4. Pack bearings and cavity between bearings with Shell Alvania No. 2 Grease or substitute. Slide bearings and shaft into bearing housing bore and install snap ring.
5. Apply a thin coat of Loctite "A" to outside diameter of new bearing housing front oil seal and press seal into housing (with seal lip facing inward) until it bottoms out.

IMPORTANT: Be sure to support impeller end of pump shaft, when installing pulley hub, in next step, to prevent placing a load on bearings.

6. Apply Special Lubricant 101 to pump shaft. Using an arbor press and appropriate tool, press pulley hub onto pump shaft to dimension shown.



a - .260" (6.6mm)

Pulley Hub Dimension

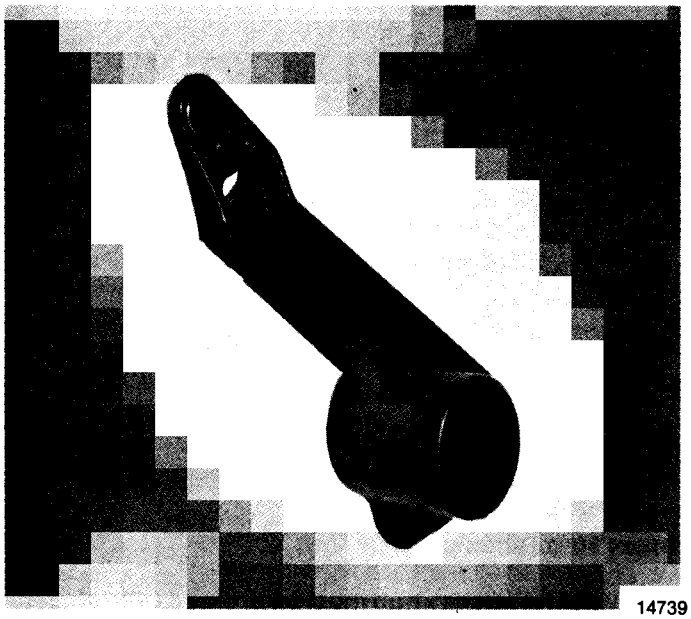
IMPORTANT: Pulley hub must be pressed onto shaft to exact dimension on pumps with stamped steel mounting bracket as this establishes proper drive belt alignment.

7. Clamp bearing housing in a soft jawed vise with flange end up.
8. Coat "O" ring (or Quad ring) with 2-4-C Marine Lubricant and install into groove in housing.
9. Place inner wear plate on housing and align holes. Coat both sides of a new wear plate gasket with a thin film of Perfect Seal and position on wear plate.
10. Install impeller into pump body by turning impeller in direction that it will be turning in operation, while simultaneously pushing inward. All impeller blades must face in same direction.
11. Apply a small amount of grease to back side of impeller drive key (to hold it in place) and position key in keyway on shaft. Align groove in impeller hub with drive key and slide impeller and pump body assembly onto shaft. Position pump body so that holes align with holes in wear plate, gasket and bearing housing. Install rubber plug into end of impeller.
12. Coat both sides of new cover gasket and wear plate gasket with a thin film of Perfect Seal. Install outer wear plate with new gaskets on each side, aligning holes in plate and gaskets with holes in pump body.
13. Install pump cover and secure with 5 screws and washers. Torque screws to specifications.

Installation

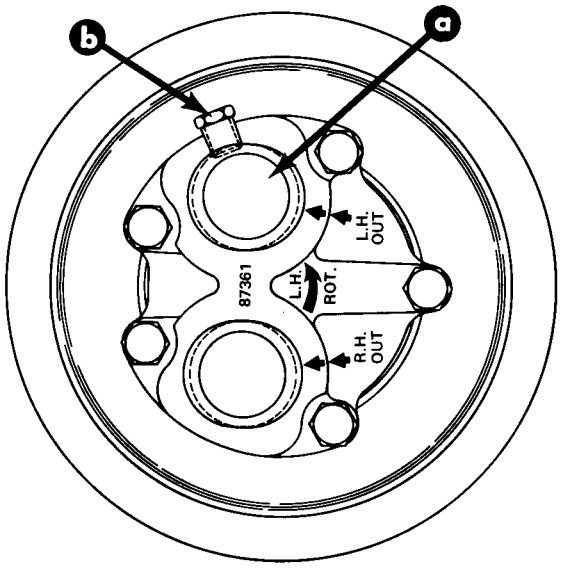
1. Position pump in mounting bracket so that outlet connection will be directly above inlet connection when pump is installed.

IMPORTANT: Pump must be positioned correctly or overheating of engine may occur.



14739

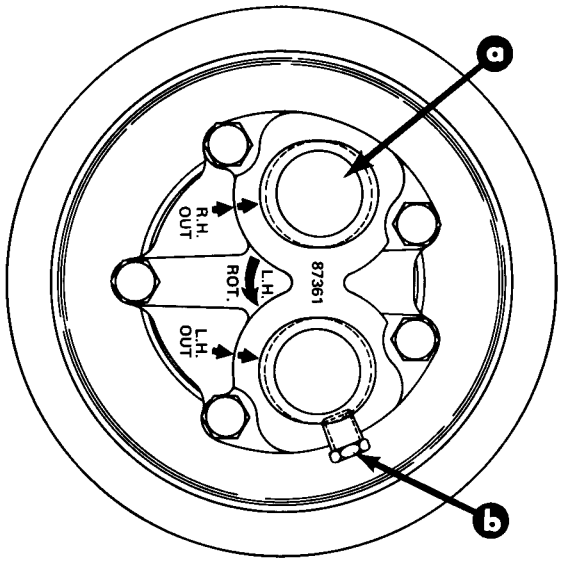
Cast Bracket



448-H

a - L.H. Out - At Top
b - Brass Plug - At Top

MCM and MIE L.H. (Standard) Rotation Engines



448-H

a - R.H. Out - At Top (Some Pumps are Not Marked. In Those Cases, "Out" is At Bottom)
b - Brass Plug - At Bottom

MIE R.H. (Opposite) Rotation Engines

1. Install flatwasher (spacer) between mounting bracket clamping bosses and install clamping screw and lockwasher. Do not tighten screw at this time.

IMPORTANT: Flat washer must be installed between mount bracket clamping bosses or damage to pump may result (if clamping screw is overtightened).

2. Attach brace to pump mounting bracket with screw, lockwasher and nut. Do not tighten at this time.
3. Install pulley on pump and secure with 4 screws, lockwashers and clamping ring (some models). Tighten screws finger tight only at this time.
4. Attach pump, mounting bracket and brace assembly to engine. Do not tighten attaching screws at this time.
5. Slide pump fore or aft in mounting bracket, as required, to properly align pump pulley with crankshaft pulley. After pump has been properly positioned, torque clamping screw to specifications.
6. Torque pump pulley attaching screws.
7. Position drive belt on pulleys and adjust belt tension as outlined in "Drive Belt Tension Adjustment" (see Index).
8. Connect seawater inlet hose to lower fitting on pump.
9. Connect outlet hose to upper fitting on pump.
10. Tighten hose clamps securely.
11. **Power Steering Models:** If applicable, reinstall drive belt. Adjust tension as outlined in "Drive Belt Tension Adjustment" (see Index).

Water Circulating Pump Replacement

Removal

1. Drain water from cylinder block.
2. Break loose circulating pump pulley attaching bolts. Do not remove bolts at this time.
3. **Power Steering Models:** Loosen power steering pump brace and pump mounting bolts, then pivot pump inward and remove drive belts (some models).
4. Loosen alternator brace attaching bolts and alternator mounting bolt, then pivot alternator inward and remove drive belt.
5. Remove pump pulley attaching bolts, lockwashers, clamping ring (if so equipped) and pulley.
6. Disconnect hose(s) from pump.
7. Remove bolts, which secure pump to cylinder block, and remove pump and old gaskets. (Discard gaskets.)

Cleaning and Inspection

1. Clean gasket surfaces on water pump and cylinder block.
2. Inspect water pump for blockage, cracks, sand holes, corrosion or other damage. Inspect pump impeller for cracks and erosion. Replace complete pump, if any damage exists.
3. Check impeller shaft and bearings for excessive side play. If play can be felt, replace complete pump.
4. Inspect pump pulley for bends, cracks, corrosion or other physical damage. Inspect pulley for rotational trueness. Replace pulley if damaged or untrue.

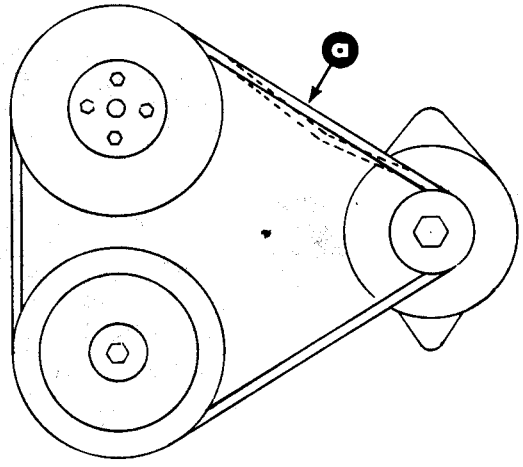
Installation

1. Coat both sides of new circulating pump gasket with Perfect Seal, then position gaskets and circulating pump on cylinder block. Coat threads of circulating pump attaching bolts with Perfect Seal and install bolts and alternator brace (if applicable). Torque bolts to specifications.
2. Reconnect hoses to pump.
3. Install pump pulley and clamping ring (if used) on pump hub and secure with bolts and lockwashers. Tighten bolts securely.
4. Install drive belts and adjust tension as outlined in. "Drive Belt Tension Adjustment" (see Index).
5. If engine is equipped with Closed Cooling, fill closed cooling section with coolant in accordance with Section 6, Part B "Filling Instructions".
6. Start engine and check for leaks.

Drive Belt Tension Adjustment

Alternator

1. Install drive belt on pulleys and adjust tension as follows
   a. Pivot alternator away from engine, as required, until correct tension is obtained as shown.
   b. After obtaining correct tension, securely retighten alternator brace attaching bolts and alternator mounting bolt.



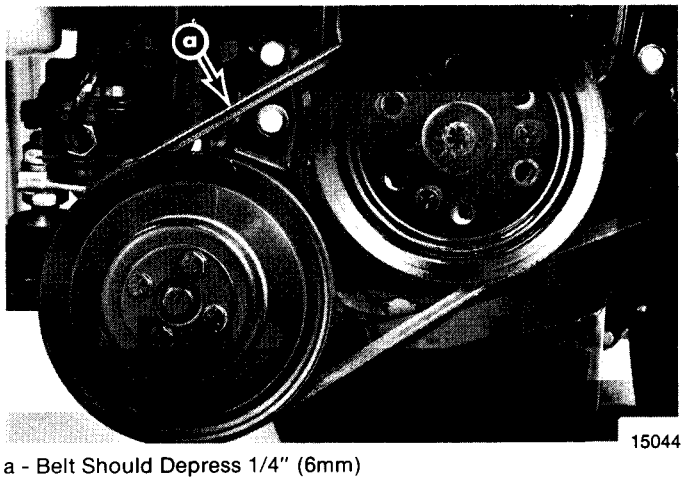
a - Belt Should Depress 1/2" (13mm)

Alternator Drive Belt Tension

2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.

Seawater Pickup Pump

1. Install drive belt on pulleys and adjust tension as follows.
   a. Pivot pump away from engine, as required, until correct tension is obtained as shown.
   b. After obtaining correct tension, securely retighten pump brace and pump mounting bolts.



15044

a - Belt Should Depress 1/4" (6mm)

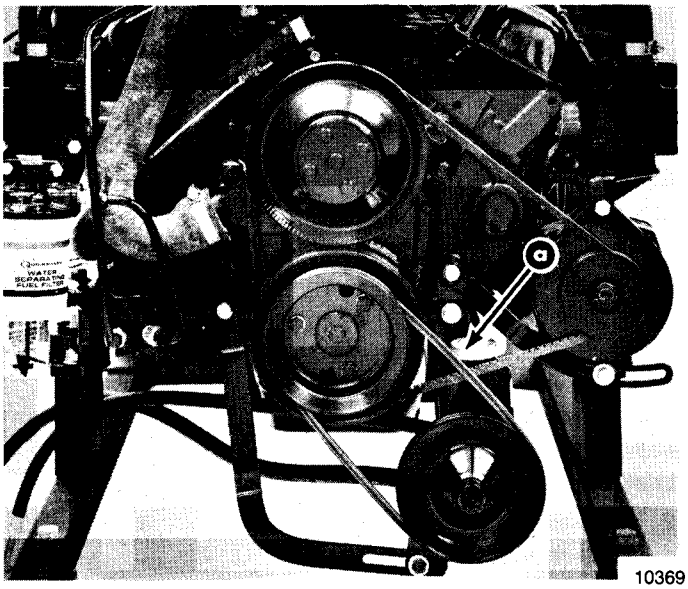
Seawater Pump Drive Belt Tension

2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.

Power Steering Pump

IMPORTANT: Do not pry on pump with pry bar or screwdriver.

1. Install drive belt on pulleys and adjust tension as shown in the following photos.
   a. Pivot pump away from engine, as required, until correct tension is obtained as shown.
   b. After obtaining correct tension, securely re-tighten pump brace and pump mounting bolts.
2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.



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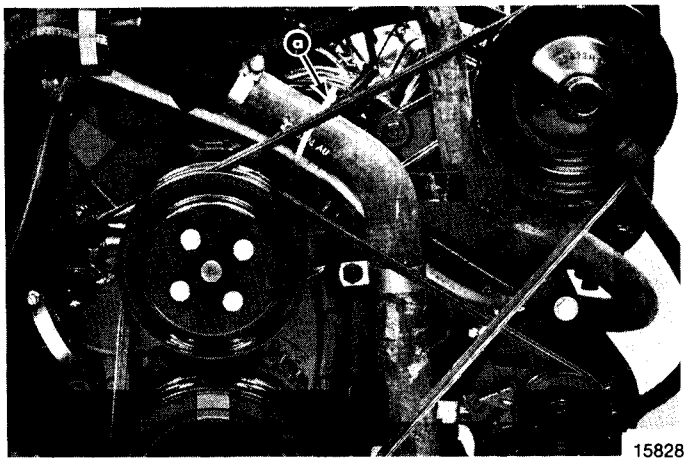
a - Belt Should Depress 1/4" (6mm)

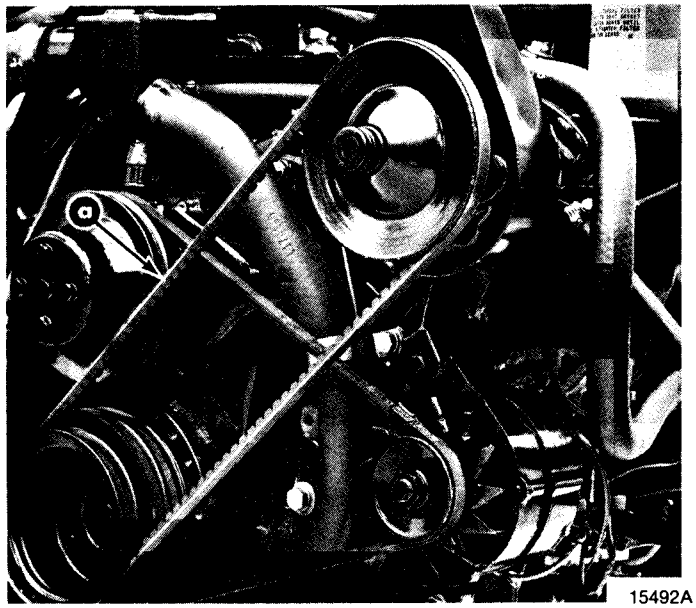
305/350 CID Models with Low Mounted Pump



15828

a - Belt Should Depress 1/4" (6mm)

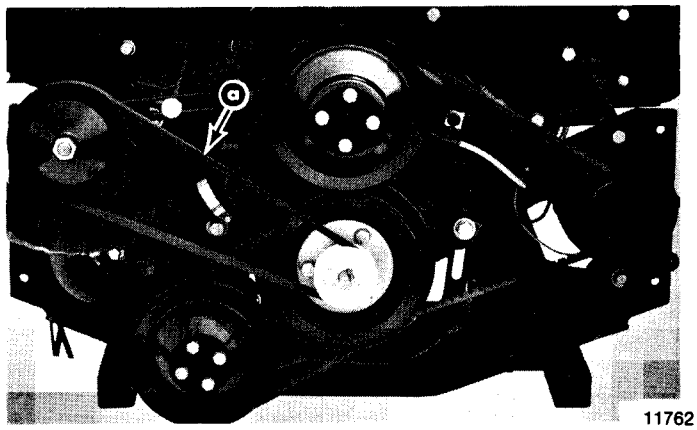
305/350 CID Models with High Mounted Pump



15492A

a - Belt Should Depress 1/2" (13mm)

454 CID Models with High Mounted Pump



11762

a - Belt Should Depress 1/4" (6mm)

454/482/540 CID Production Performance Models

Flushing Cooling System

If engine is operated in salty, polluted or mineral-laden waters, cooling system should be flushed periodically (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Cooling system also should be thoroughly flushed prior to storage.

⚠WARNING

When flushing cooling system with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby.

IMPORTANT: Do not run engine above 1500 RPM, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

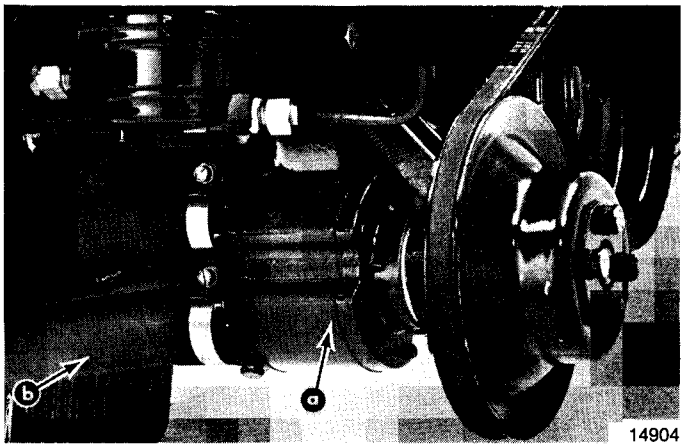
IMPORTANT: If cooling system is to be flushed with boat in the water, water inlet valve (if so equipped) must be closed, or water inlet hose must be disconnected and plugged to prevent water from flowing into boat.

IMPORTANT: If boats is in the water, do not open water inlet valve until engine is to be restarted, to prevent contaminated water from flowing back into engine.

⚠CAUTION
Watch temperature gauge at dash to ensure the engine does not overheat.

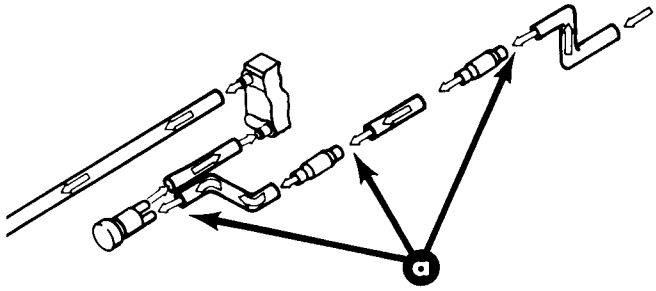
Belt Driven Seawater Pickup Pump

1. Loosen hose clamp and remove water inlet hose at location shown.



a - Seawater Pickup Pump
b - Seawater Inlet Hose

Models with Belt Driven Seawater Pump



a - Disconnect Hose - Cooling Water Must Flow Thru Cooler(s) if Engine is so Equipped

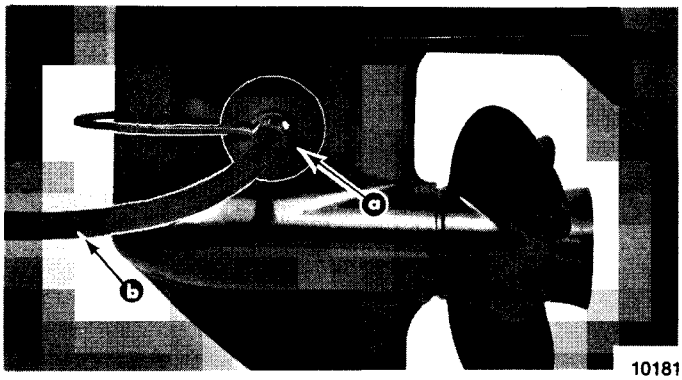
Production Performance Models

2. Partially open water tap (approx. 1/2 maximum capacity) and allow cooling system to fill completely. Cooling system is full when water is discharged thru the exhaust. Do not use full water tap pressure.
3. Place the remote control lever in neutral position and start the engine. Operate engine at idle speed in neutral gear for 10 minutes or until discharge water is clear, then stop engine.
4. Shut off water tap. Remove flushing connector from pump inlet and reconnect water inlet hose. Be sure to tighten clamp securely.

Stern Drive Unit Seawater Pickup Pump

IMPORTANT: MCM 200/230/260 Engines: if engine has a Closed Cooling system or is a Drive Shaft Extension model refer to Figure below also, if cooling system is going to be flushed with boat out of water. Two independent water connects are required on these models.

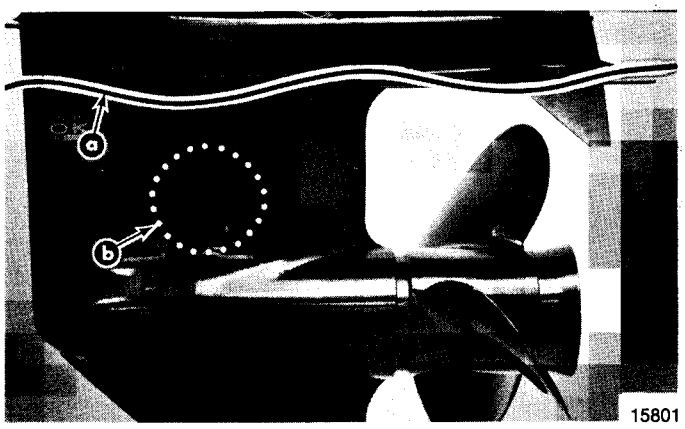
1. Install Flush Device and connect garden hose between it and water tap.



a - Flush Device
b - Garden Hose

Models with Stern Drive Seawater Pump

2. Salt water areas and boat in the water:
   a. Raise stern drive unit to full trailer position.
   b. Install flush device over water intake holes.
   c. Lower stern drive unit to full down position.



a - Minimum Water Level
b - Water Intake Holes

Minimum Water Level

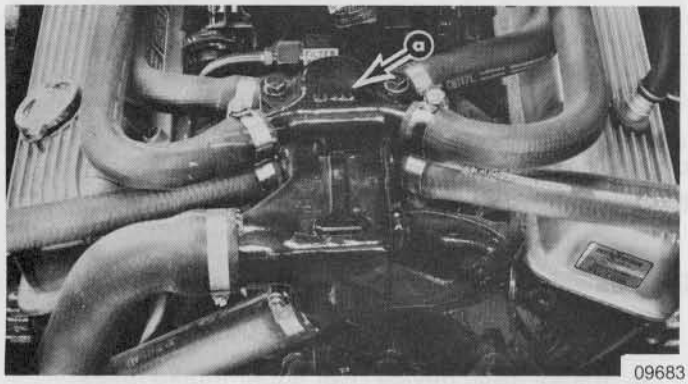
3. Partially open water tap (approx. 1/2 maximum capacity) and allow cooling system to fill completely. Cooling system is full when water is discharged thru the propeller. Do not use full water tap pressure.

4. Place remote control in neutral position and start engine. Watch temperature gauge on instrument panel to ensure that engine does not overheat.
5. Stop engine, turn off water tap and remove Flush Device.

Thermostat

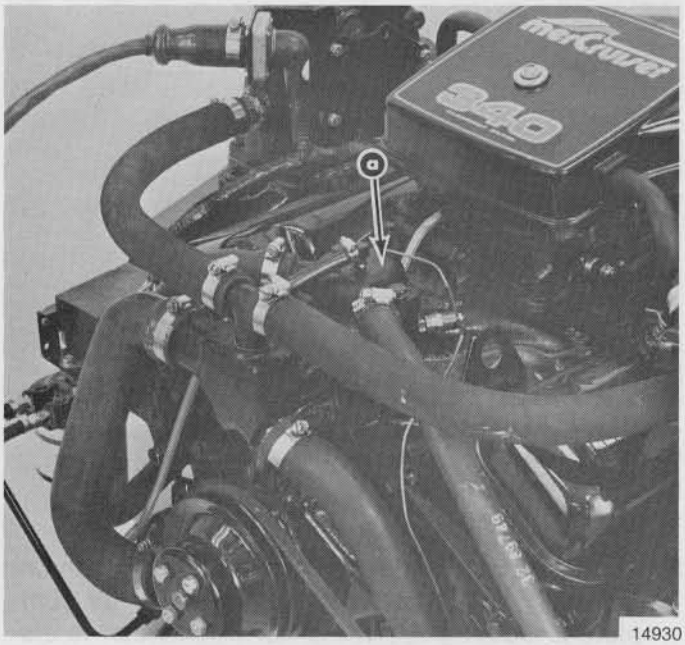
Removal

1. Drain water from cylinder block and exhaust manifolds.
2. Disconnect hoses from thermostat cover.
3. Remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket.
4. Remove thermostat from thermostat housing or cover.



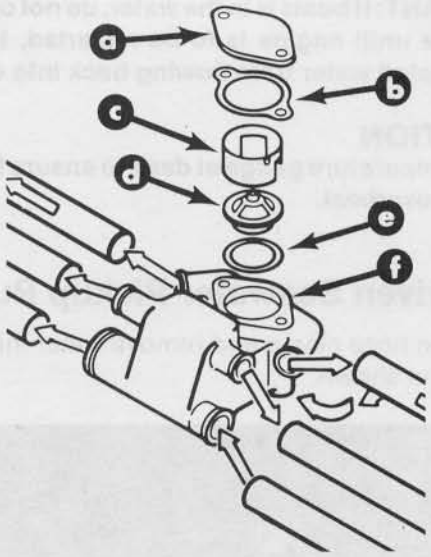
a - Thermostat Housing Cover

Models without "T" Fitting on Housing Cover



a - Thermostat Housing Cover

Models with "T" Fitting on Housing Cover

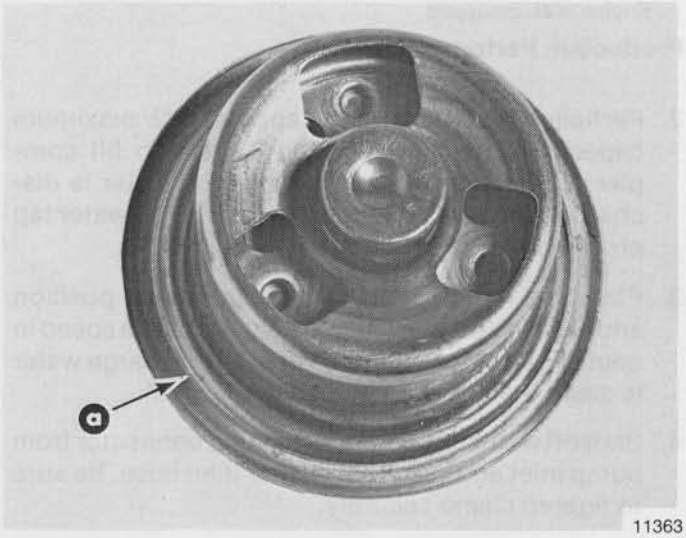


a - Cover
b - Gasket
c - Spacer
d - Thermostat
e - O-Ring
f - Housing

NOTE: Some 1988 Models will have redesigned thermostat housing.

Testing

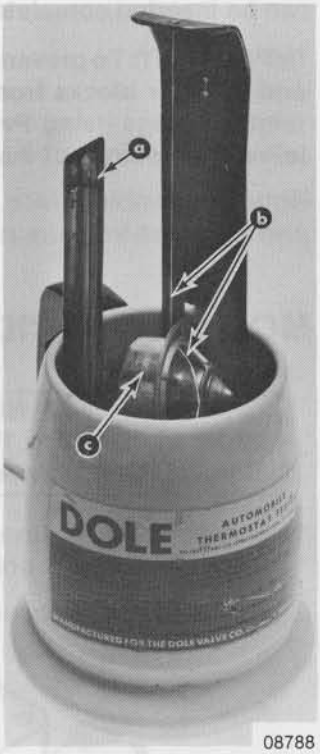
1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to a lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or 2 points around the valve perimeter is acceptable.)



a - Check for Light Leakage Around Perimeter of Valve

Checking Typical Thermostats for Leakage

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown as follows:
   a. Fill tester to within 1" (25mm) of top with tap water. Do not use distilled water.
   b. Open thermostat valve and insert nylon string. Position thermostat on string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.
   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.



a - Thermometer
b - Nylon String
c - Thermostat

Thermostat Tester 08788

IMPORTANT: When performing Steps d-thru-f, water must be agitated throughly to obtain accurate results.

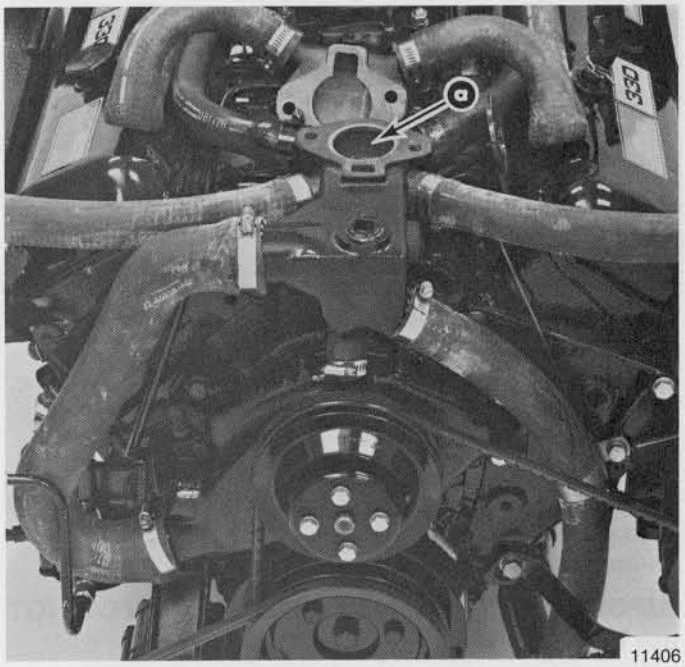
   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at specified temperature stamped on thermostat.
   e. Continue to heat water until a temperature 25° F (14° C) above temperature specified on thermostat is obtained. Thermostat valve must be completely open at this temperature.
   f. Unplug tester and allow water to cool to a temperature 10° F (5° C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.
   g. Replace a thermostat that fails to meet all of the preceding tests.

Installation

1. Clean gasket surfaces on thermostat cover and thermostat housing.
2. If thermostat housing was disturbed during removal of thermostat, remove thermostat housing and replace thermostat housing to intake manifold gasket. Before installing, coat both sides of new gasket (without continuity rivets) with Perfect Seal.

IMPORTANT: If gasket has continuity rivets, Do not coat with Perfect Seal or Audio Warning temperature switch may not work properly.

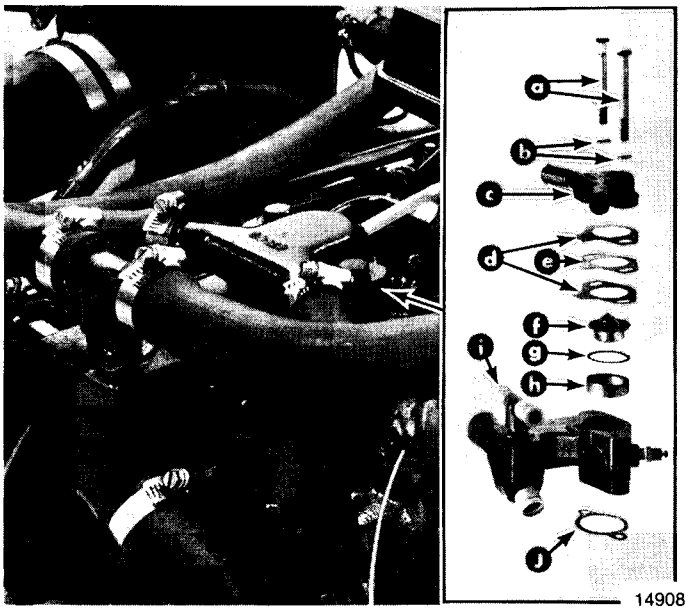
3. Place thermostat in thermostat housing with thermostatic element end toward housing. Be sure to position thermostat so that mounting flange fits into recess in thermostat housing.



11406

All Models (With or Without T Fitting)

4. Coat both sides of new thermostat cover to thermostat housing gasket with Perfect Seal and position on thermostat housing. Reinstall thermostat cover and torque bolts to specifications.
5. Reconnect hose(s) to thermostat cover.
6. Start engine and inspect for leaks.



14908

a - Screws
b - Lockwashers
c - Cover
d - Upper Gaskets (Coat Both Sides with Perfect Seal)
e - Stainless Steel Separator Plate
f - Thermostat
g - Cork Gasket
h - Sleeve (Install with Turned-In Edge Up)
i - Thermostat Housing
j - Gasket (Coat With Perfect Seal)

IMPORTANT: If gasket has continuity rivets DO NOT use Perfect Seal.

Out-Of-Season Storage (Draining)

Draining Precautions

IMPORTANT: If the possibility of freezing exists, cooling system must be drained to prevent freeze damage to cooling system. Cooling system also should be drained if boat is to be stored for an extended period of time to prevent corrosion damage.

⚠CAUTION
Cooling system, must be completely drained for storage, or trapped water may cause freeze and/or corrosion damage to engine.

⚠CAUTION
If boat is in the water, water inlet valve (if so equipped) must be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a valve, water inlet hose must be left disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve must be opened or the water inlet hose reconnected prior to starting the engine.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On later models with two piece petcocks, removal of petcock may be required so that wire can be inserted completely into drain hole.

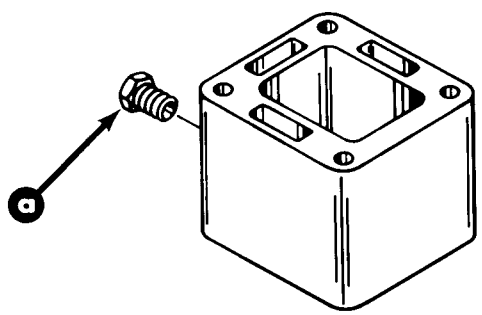
IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Perfect Seal on threads. Never leave drain plugs out during storage.

Note: If possible, place a container under drains to prevent water from draining into boat.

MCM 305/350 CID Models

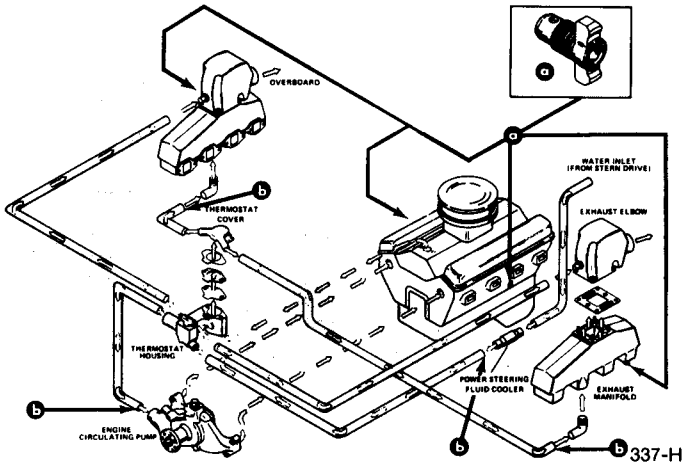
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown.



a - Drain Plug - Remove

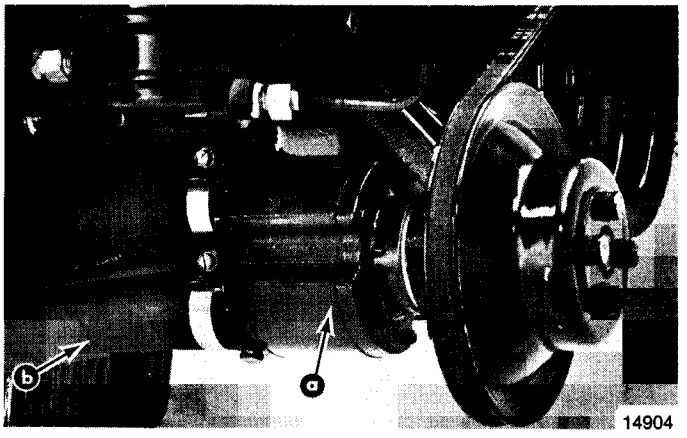
3" or 6" Risers (If Equipped)



a - Petcocks - Remove
b - Remove hoses to Lower Drain

Engine Drain Locations

3. **MCM 200/230/260 Driveshaft Extension Models:** Remove seawater inlet hose.

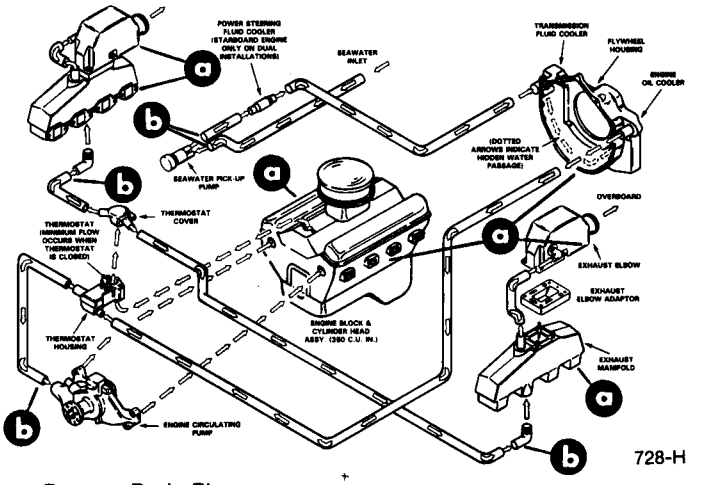


a - Seawater Pickup Pump
b - Seawater Inlet Hose

Driveshaft Extension Models

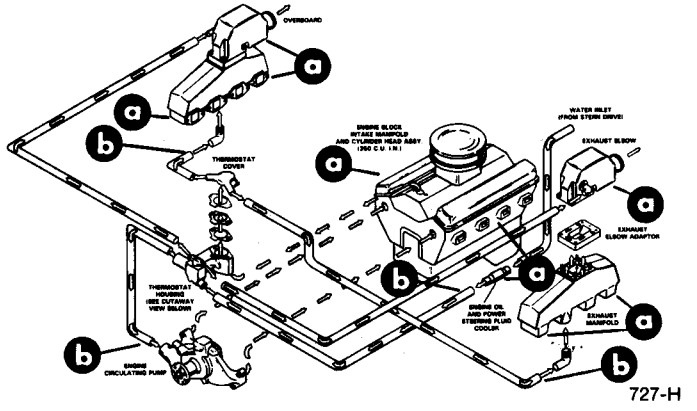
MCM 300 Tempest/Alpha One/TRS

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown.



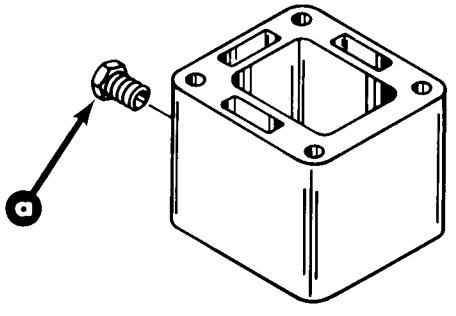
a - Remove Drain Plug
b - Remove Hose (Lower to Drain)

MCM 300 Tempest TRS



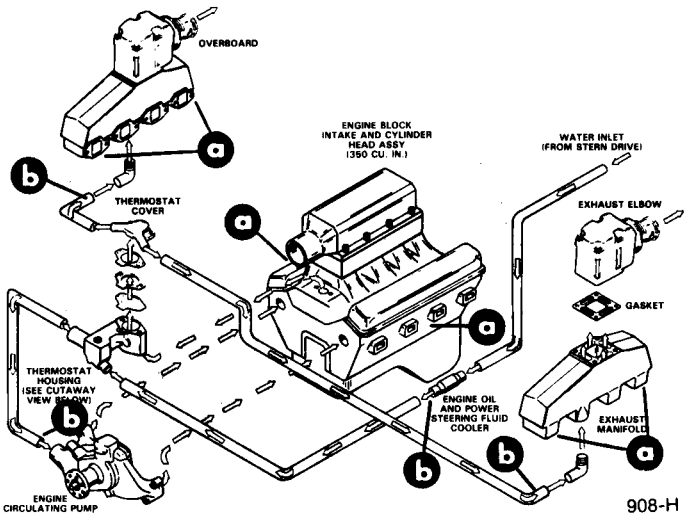
a - Remove Drain Plug
b - Remove Hose (Lower to Drain)

MCM 300 Tempest Alpha One



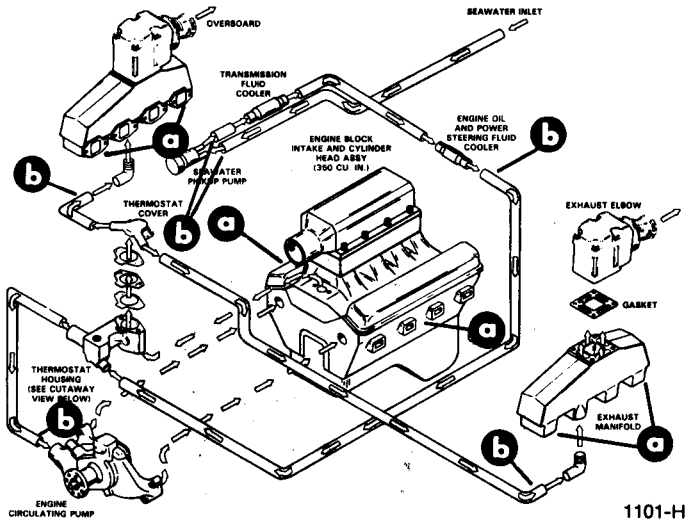
a - Drain Plug - Remove

Risers (If Equipped)



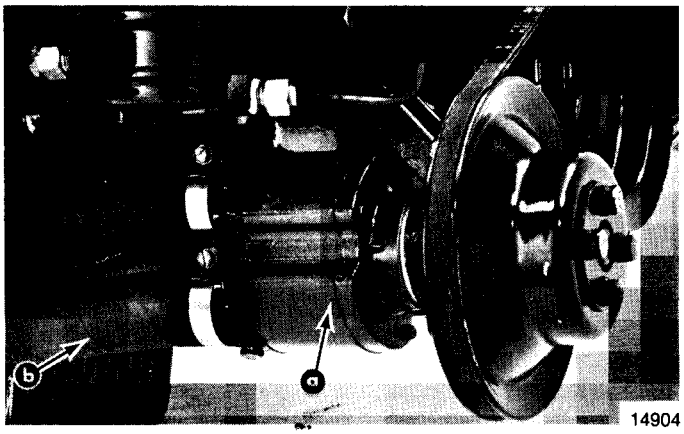
a - Remove Drain Plug
b - Remove Hose (Lower to Drain)

MCM 320 EFI Alpha I Drive



a - Remove Drain Plug
b - Remove Hose (Lower to Drain)

MCM 320 EFI Bravo Drive

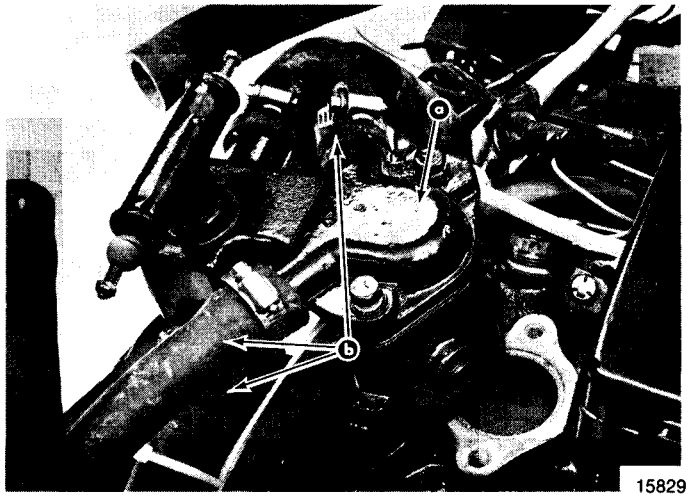


a - Seawater Pickup Pump
b - Hose - Remove

Seawater Pickup Pump

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect all hoses. Tighten clamps securely.

4. For additional assurance against freezing and rust, fill cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage).



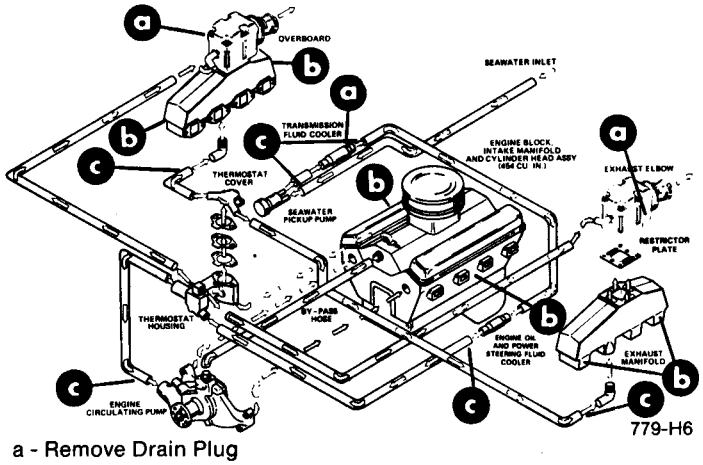
a - Remove Cover and Thermostat Housing. Fill with Coolant until Block and Heads are Full. Using New Gasket, Install Thermostat and Cover. Torque Screw to Specifications
b - Remove Hoses. Fill Manifolds with Coolant. Reinstall Hoses and Tighten Clamps Securely.

Filling With Coolant

MCM 454 CID Models (7.4 Litre and 1988 454 Magnum Included)

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

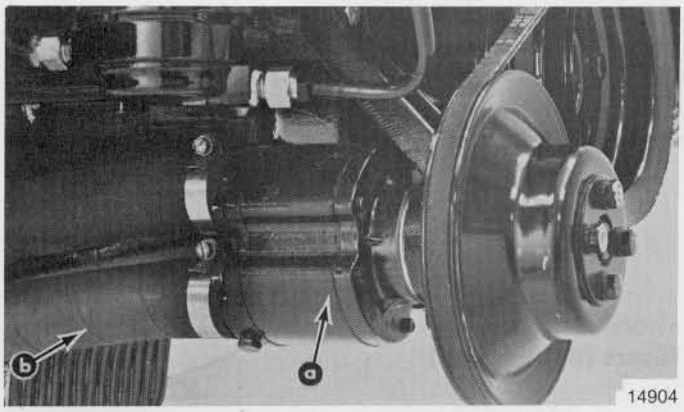
1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown.



a - Remove Drain Plug
b - Remove Petcock
c - Remove Hose (Lower to Drain)

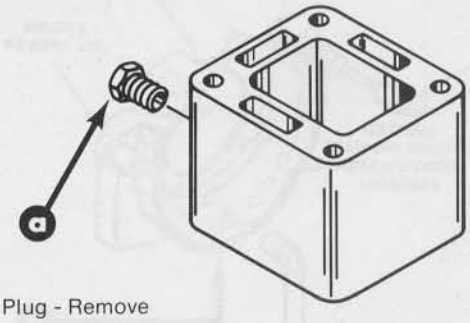
Cooling System Drain Locations

NOTE: Some models fluid coolers may be in slightly different locations.



a - Seawater Pickup Pump
b - Hose Remove

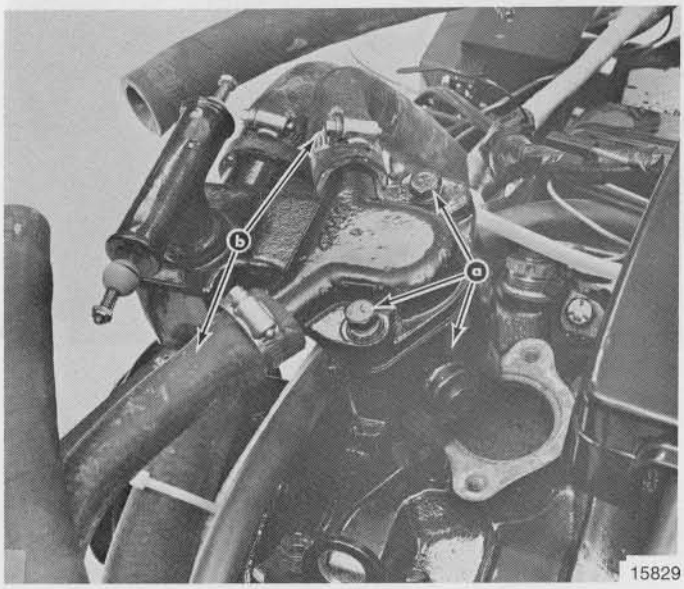
Seawater Pickup Pump



a - Drain Plug - Remove

3" or 6" Riser (If Equipped)

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcocks and reconnect all hoses. Tighten clamps securely.



a - Remove Screws and Thermostat Housing. Fill with Coolant until Block and Heads are Full. Using New Gasket, with Continuity Rivets (Do Not Use Perfect Seal). Install Housing. Torque Screws to Specifications
b - Remove Hoses and Fill Manifolds with Coolant. Reinstall Hoses and Tighten Clamps Securely.

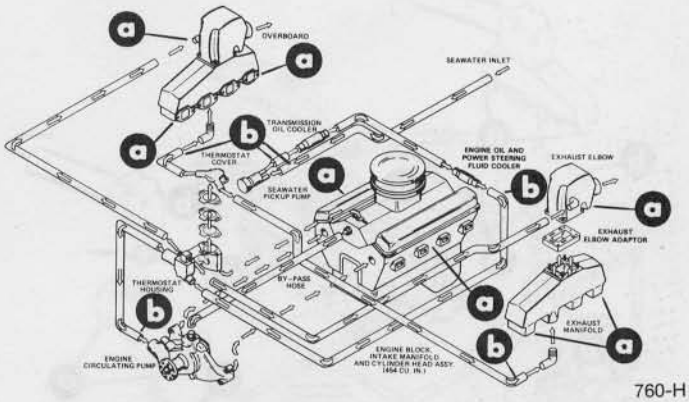
Filling with Coolant

4. For additional assurance against freezing and rust, fill cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage).

MCM 454/482/540 CID Production Performance Models

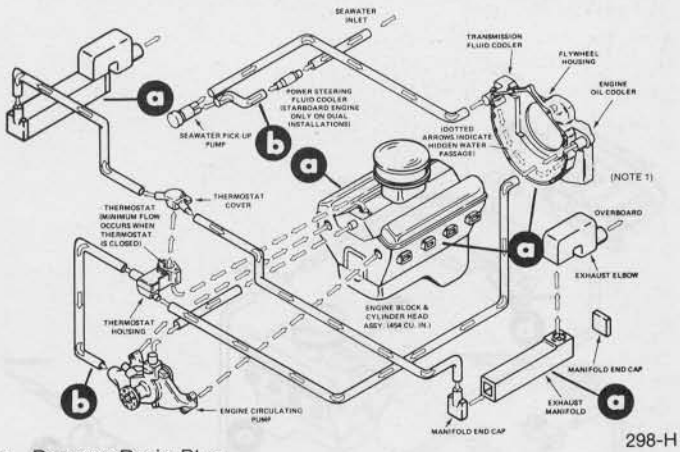
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine higher to properly drain cooling system.
2. Drain cooling system as shown.



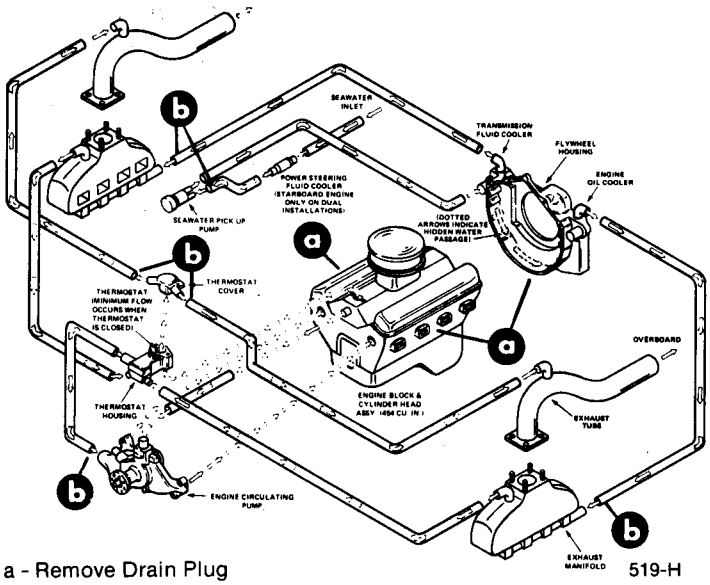
a - Remove Drain Plug
b - Remove Hose (Lower to Drain)

MCM 370TRS/400 Cyclone S/N 6721528 and Above



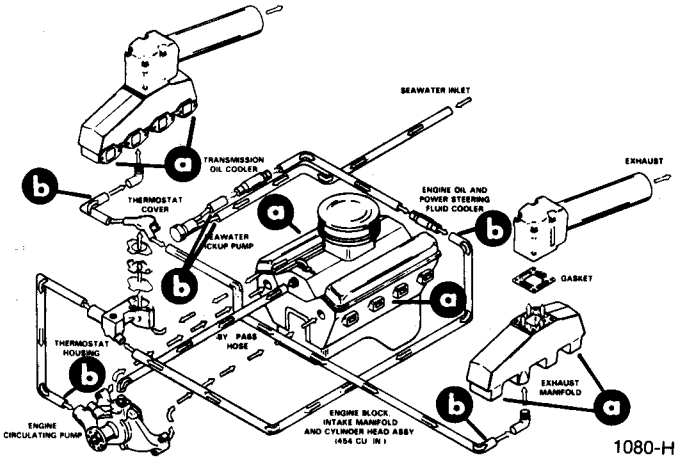
a - Remove Drain Plug
b - Remove Hose (Lower to Drain)

MCM 370TRS/400 Cyclone S/N 6721527 and Below



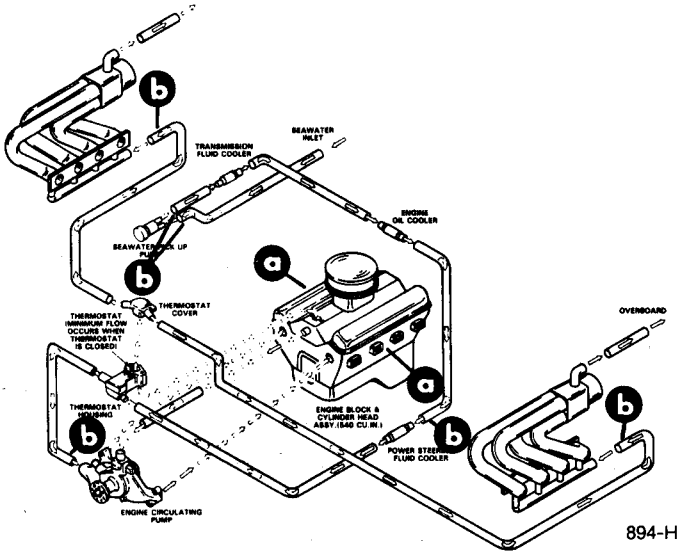
a - Remove Drain Plug
b - Remove Hose (Lower to Drain)

MCM 440/460 Cyclone



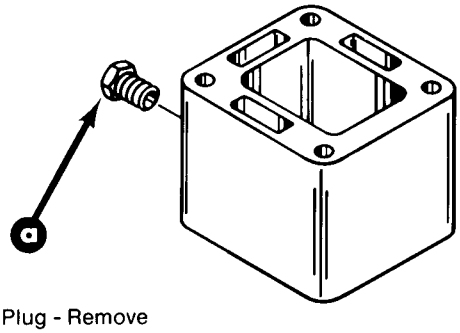
a - Remove Drain Plug
b - Remove Hose (Lower to Drain)

MCM 420



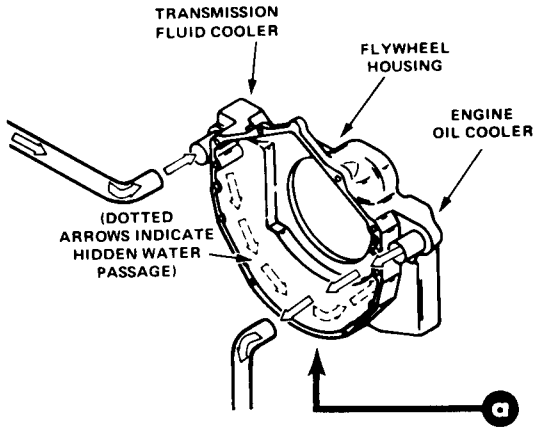
a - Remove Drain Plug
b - Remove Hose (Lower to Drain)

MCM 575



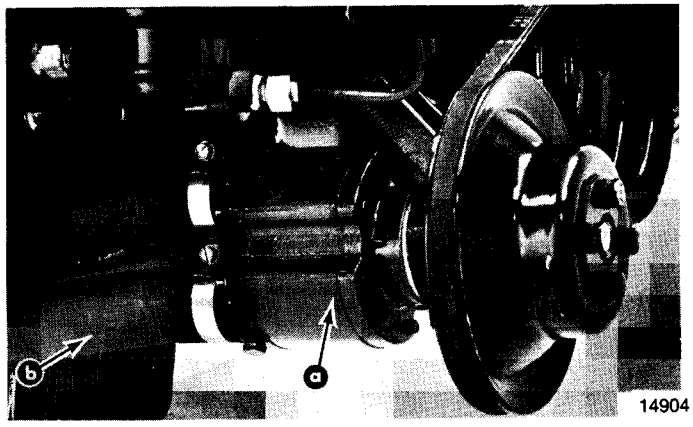
a - Drain Plug - Remove

Risers (If Equipped)



a - Drain Plug on Bottom of Flywheel Housing - Drains Both Coolers

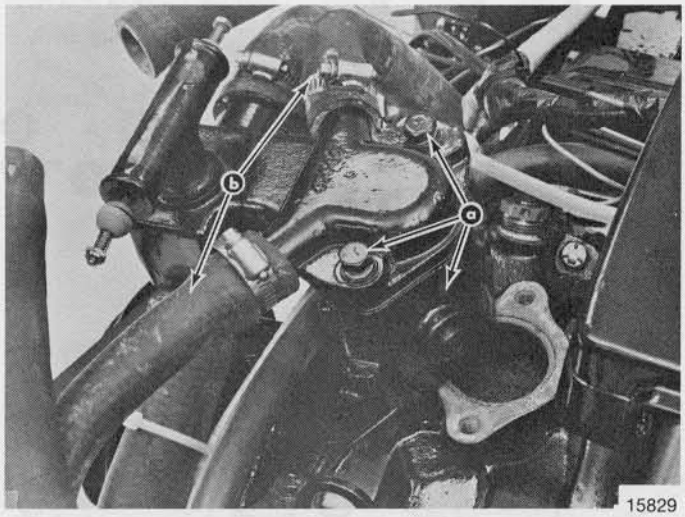
Dual Cooler Flywheel Housing



a - Seawater Pickup Pump
b - Hose - Remove

Seawater Pickup Pump

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect all hoses. Tighten clamps securely.
4. For additional assurance against freezing and rust, fill cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacture for lowest temperature to which engine will be exposed to during storage).



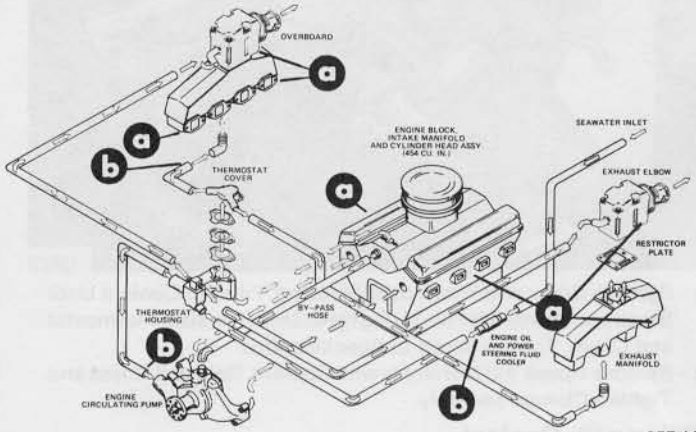
a - Remove Screws and Thermostat Housing. Fill with Coolant until Block and Heads are Full. Using New Gasket, with Continuity Screws to Specifications
b - Remove Hoses and Fill Manifolds with Coolant. Reinstall Hoses and Tighten Clamps Securely.

Filling With Coolant

MCM 454 Magnum

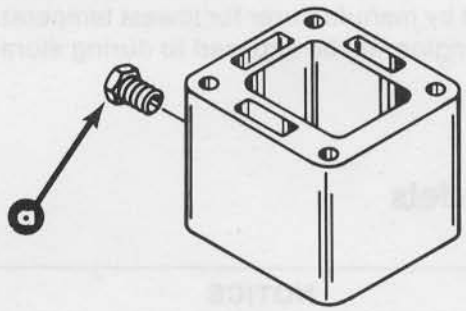
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine higher to properly drain cooling system.
2. Drain cooling system as shown.



a - Remove Drain Plug
b - Remove Hose (Lower To Drain)

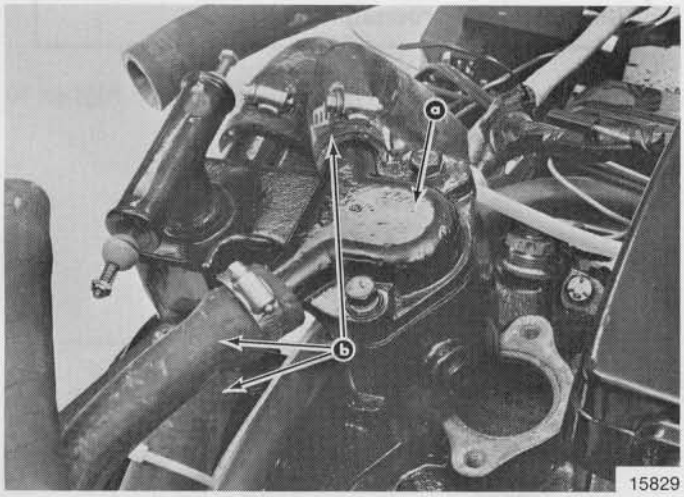
MCM 454 Magnum (1987)



a - Remove Drain Plug

3" or 6" Risers (If Equipped)

4. After cooling system has drained completely, coat threads of drain plug(s) with Perfect Seal and reinstall. Close petcock and reconnect all hoses. Tighten clamps securely.



15829

a - Remove Cover and Thermostat Housing. Fill with Coolant Until Block and Heads are Full. Using New Gasket, Install Thermostat and Cover. Torque Screw to Specifications
b - Remove Hoses. Fill Manifolds with Coolant. Reinstall Hoses and Tighten Clamps Securely

Filling with Coolant

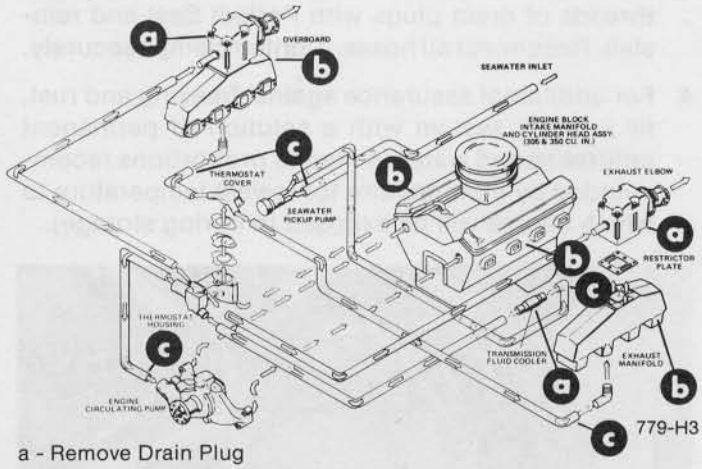
5. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage).

MIE Models

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.

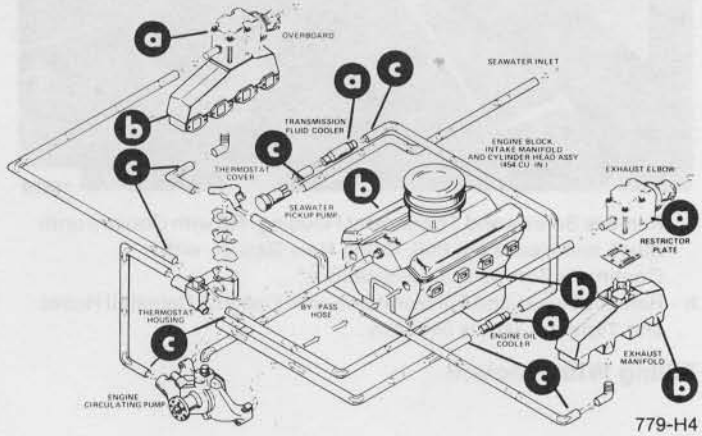
2. Drain system as shown.



779-H3

a - Remove Drain Plug
b - Remove Petcock
c - Remove Hose (Lower to Drain)

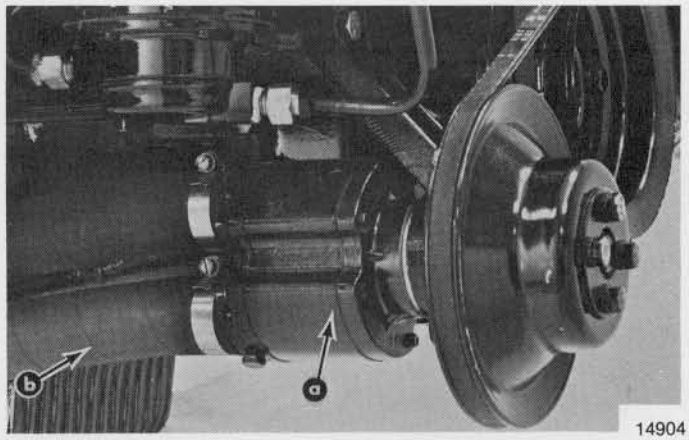
MIE 230/260



779-H4

a - Remove Drain Plug
b - Remove Petcock
c - Remove Hose (Lower to Drain)

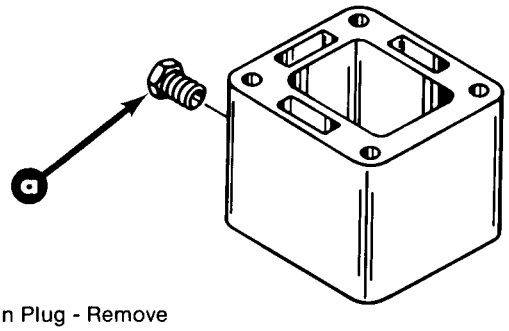
MIE 340



14904

a - Seawater Pickup Pump
b - Seawater Inlet Hose

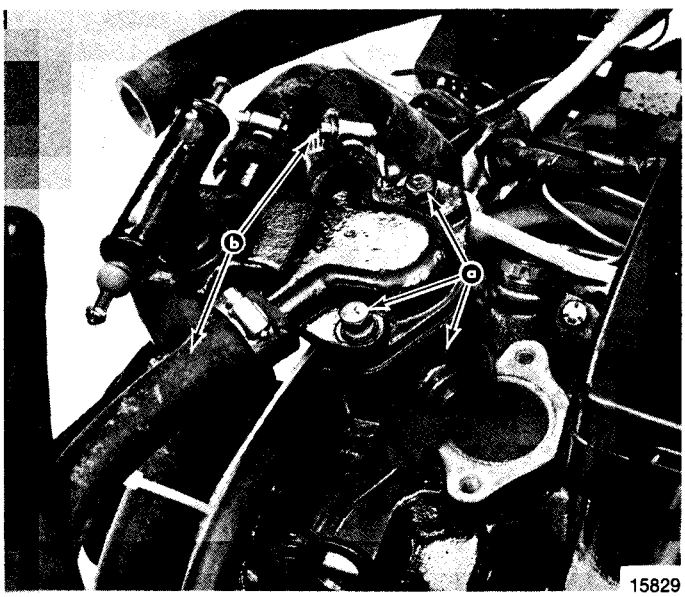
Seawater Pickup Pump



a - Drain Plug - Remove

3" or 6" Risers (If Equipped)

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcock and reconnect all hoses. Tighten clamps securely.
4. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage).



a - Remove Screws and Thermostat Housing. Fill with Coolant until Block and Heads are Full. Using New Gasket, Install Housing. Torque Screws to Specifications

b - Remove Hoses and Fill Manifolds with Coolant. Reinstall Hoses and Tighten Clamps Securely

Filling With Coolant

Auxiliary Hot Water Heater Installation

When connecting a cabin heater or hot water heater to a MerCruiser engine, certain requirements must be met.

- Supply hose (from engine to heater) and return hose (from heater to engine) must not exceed 5/8" (16mm) (Inside Diameter).
- **MerCruiser Engines Equipped With a Closed Cooling System:** Heater must be lower than the fill cap on the heat exchanger. If the heater is higher than the fill cap on the heat exchanger and some coolant is lost in the system, an air pocket may form in the closed cooling system. This in turn, can cause the engine to overheat.

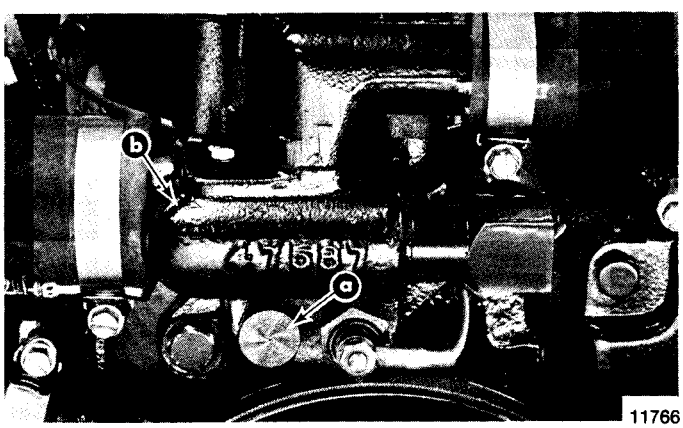
  Make heater connections to MerCruiser engines only at locations shown.

  Check complete system for leaks after heater is connected into cooling system.

  Check for overheating condition (of engine) after heater is connected into cooling system.

MCM/MIE V-8 Engines (74567A1 Kit)

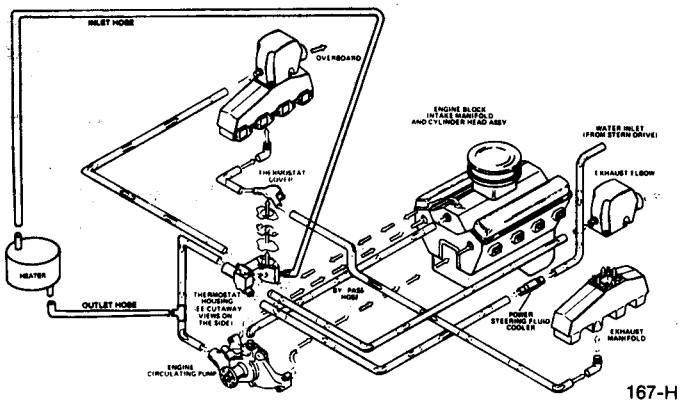
1. Drain cooling system.
2. Remove thermostat housing assembly from intake manifold. Do not remove cover from thermostat housing.
3. Remove 3/8" NPT plug from aft port side of thermostat housing.
4. Install the appropriate type fittings(s) (obtain from local source) in threaded hole from which pipe plug was removed to allow connection of water heater supply hose. Coat threads of fitting(s) with Perfect Seal before installing.
5. Reinstall thermostat housing using new gasket. Torque bolts to specifications.
6. Connect hot water heat supply hose to fitting and secure with a clamp (not provided).



a - 3/8" NPT Plug b - Thermostat Housing

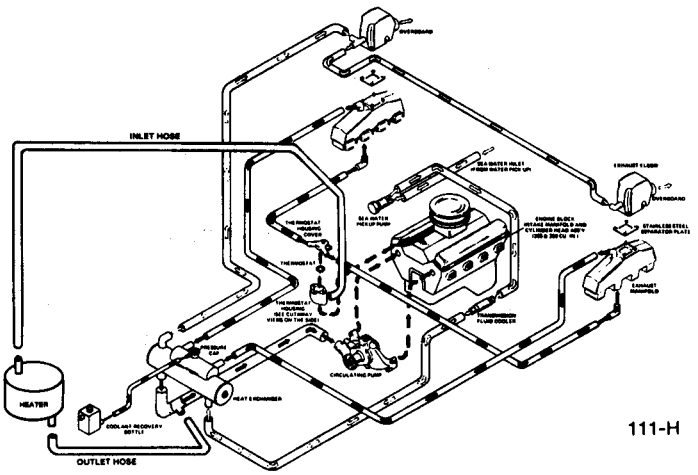
Water Heater Supply Hose Conection

7. Connect auxiliary hot water heater return hose into cooling system with "T" fitting and hose clamps as shown. Cut approximately 3/4" (19mm) out of hose to maintain proper hose configuration.
8. Tighten "T" fitting hose clamps securely.
9. Support hoses, as required, to ensure that they do not rub or chafe against engine components.
10. With boat in the water, start engine and check for:
    a. Leaks
    b. Overheating



167-H

Heater Connection on Typical MerCruiser V-8 (GM) Engine with Standard Cooling



111-H

Heater Connection on Typical MerCruiser V-8 (GM) Engine with Closed Cooling System

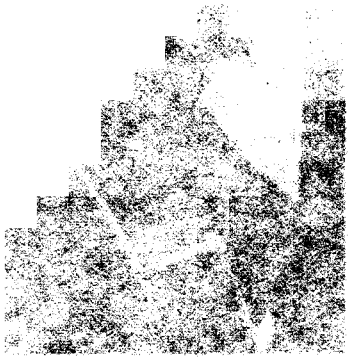
Cooling System Flow Diagrams

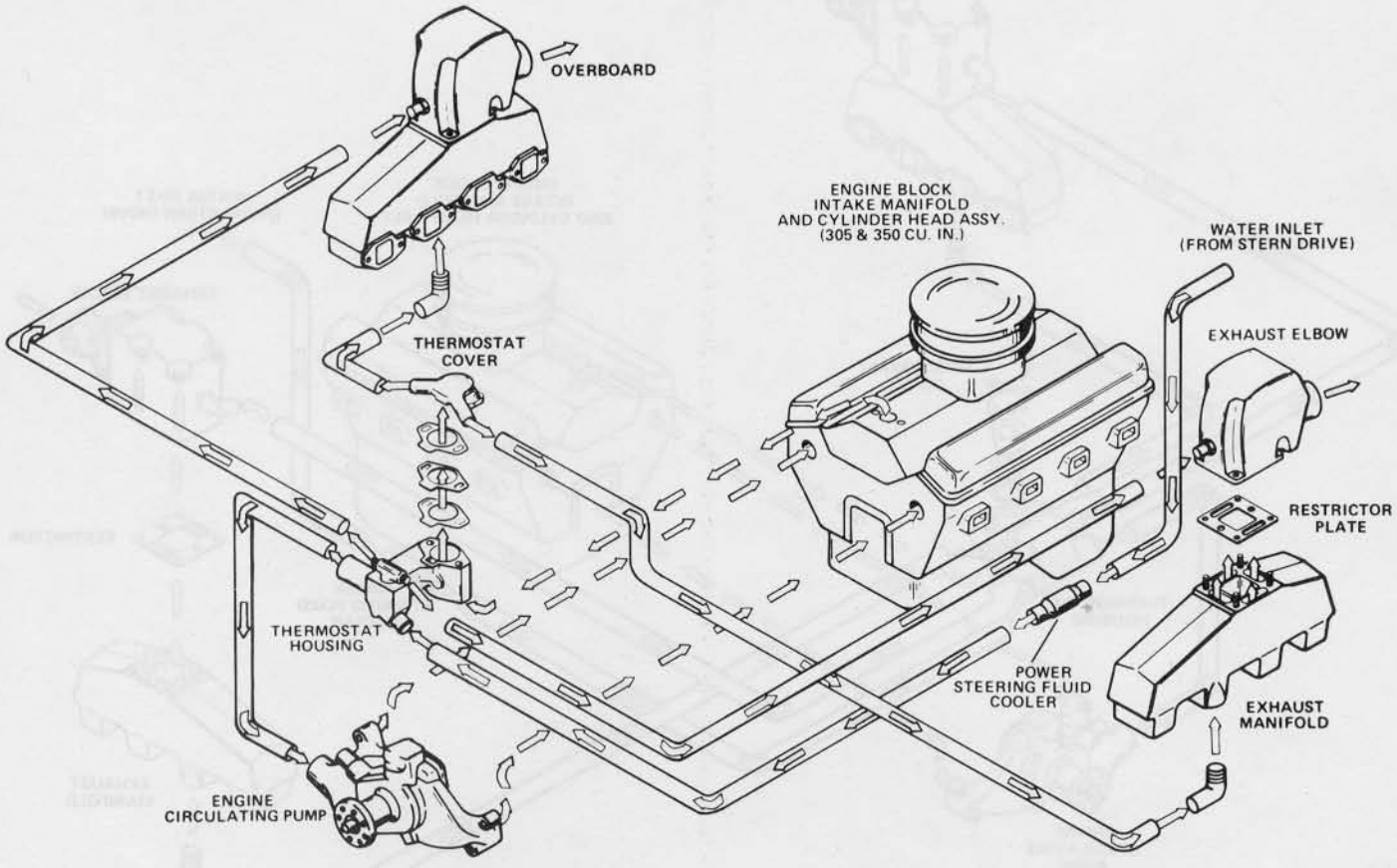
MerCruiser engines with standard cooling systems use seawater (water in which the boat is being operated) to remove the heat given off by the engine.

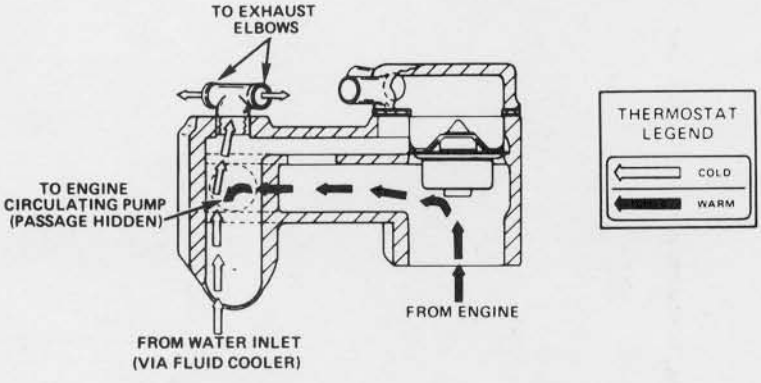
The seawater is pumped to the cooling system by means of an impeller type pickup pump (located in the vertical drive or belt driven at the front of engine) which picks up seawater and delivers it to the centrifugal pump (located over an opening on the front of the cylinder block). On some models, seawater may be pumped through an oil cooler before going to the circulating pump. The centrifugal pump then circulates the seawater through the block, heads and manifolds, removing the heat given off by these parts as it passes.

After passing through the engine, the seawater is pumped into the exhaust elbow, where it mixes with the exhaust gases, and is expelled overboard.

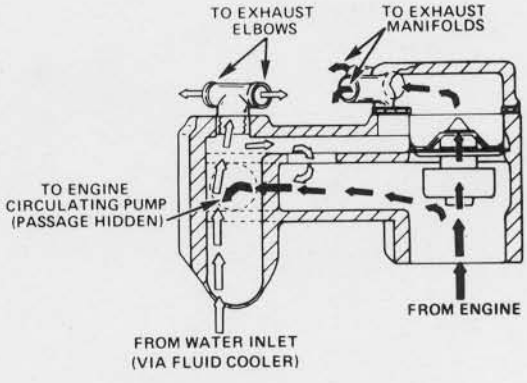
A thermostatic heat control which controls circulation of the seawater, also is incorporated into the system. It provides fast engine warmup and controlled operating temperature.







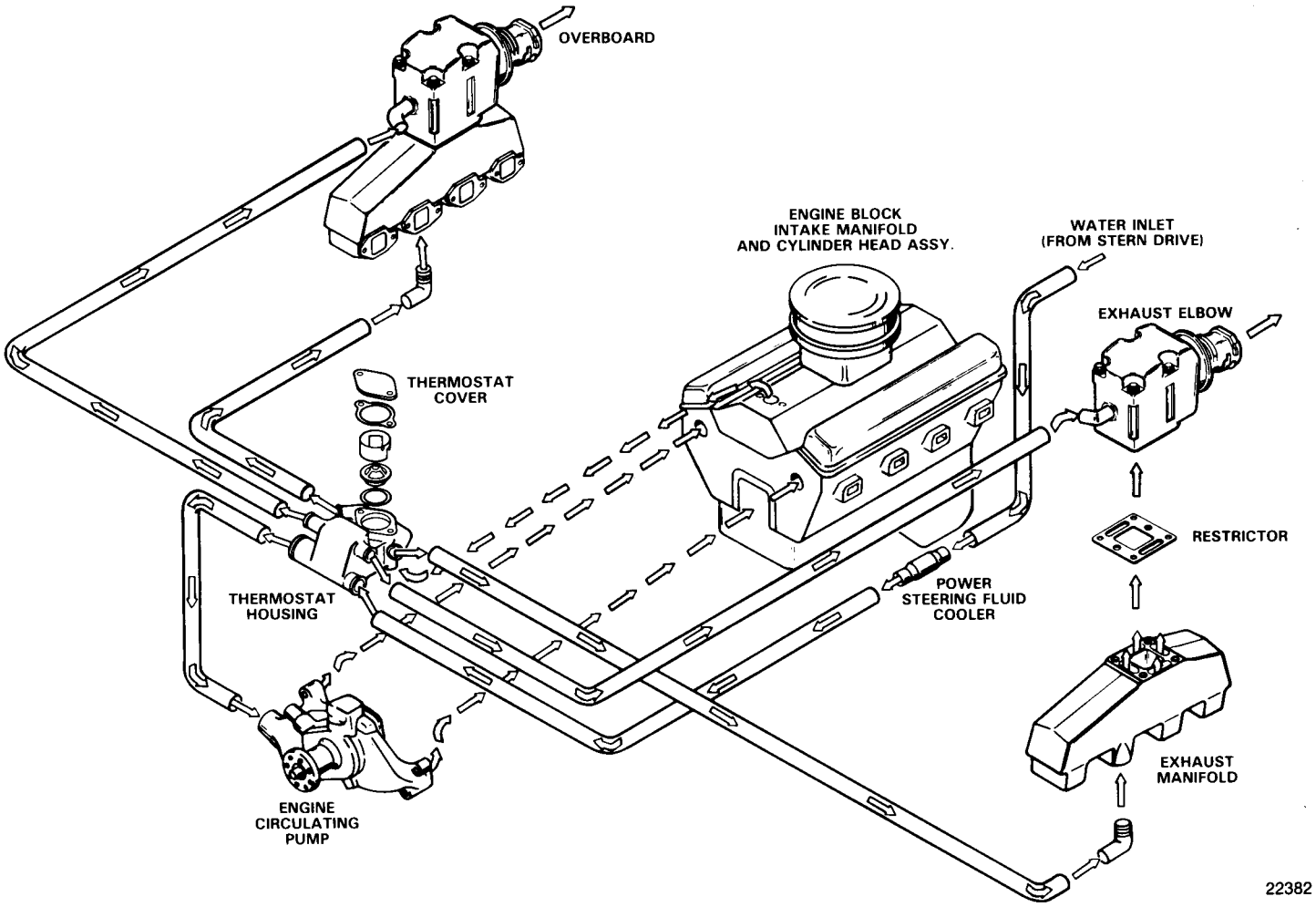
COOLANT FLOW THROUGH THERMOSTAT
HOUSING WITH THERMOSTAT CLOSED



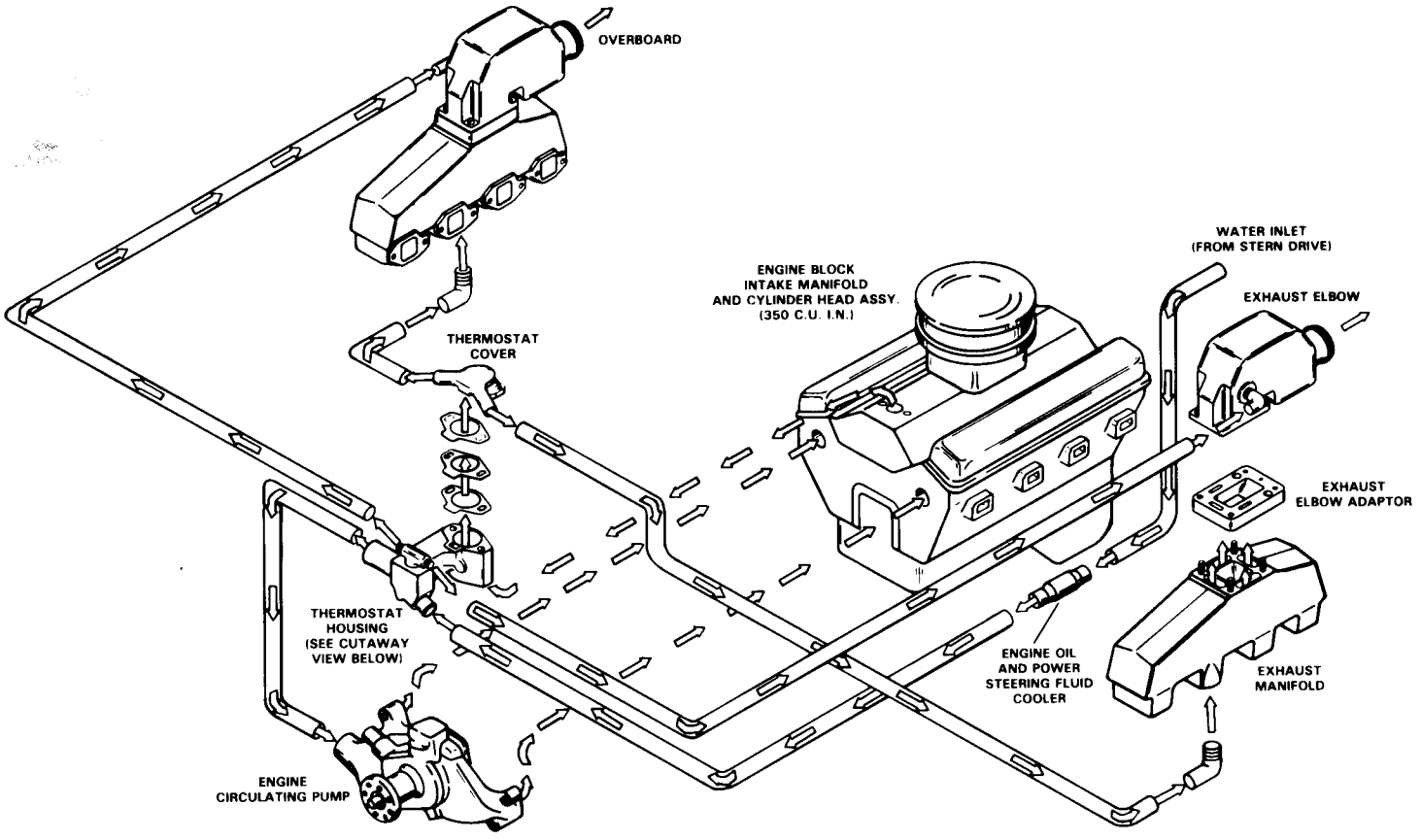
COOLANT FLOW THROUGH THERMOSTAT
HOUSING WITH THERMOSTAT OPEN

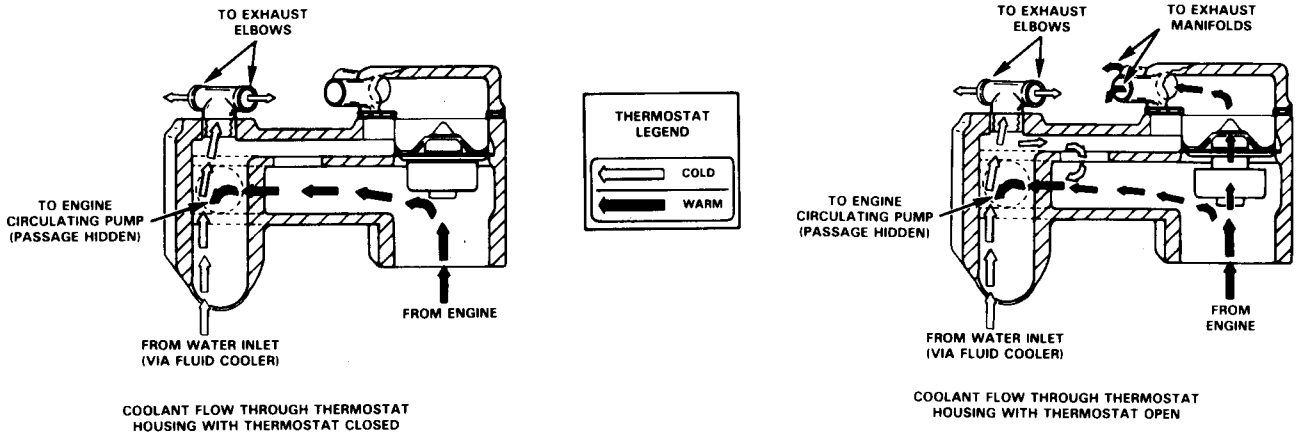
MCM 200/230/260/350 Magnum

167-HR



5.0 Litre/5.0 Litre LX/5.7 Litre/350 Magnum
(With Redesigned Thermostat Housing)



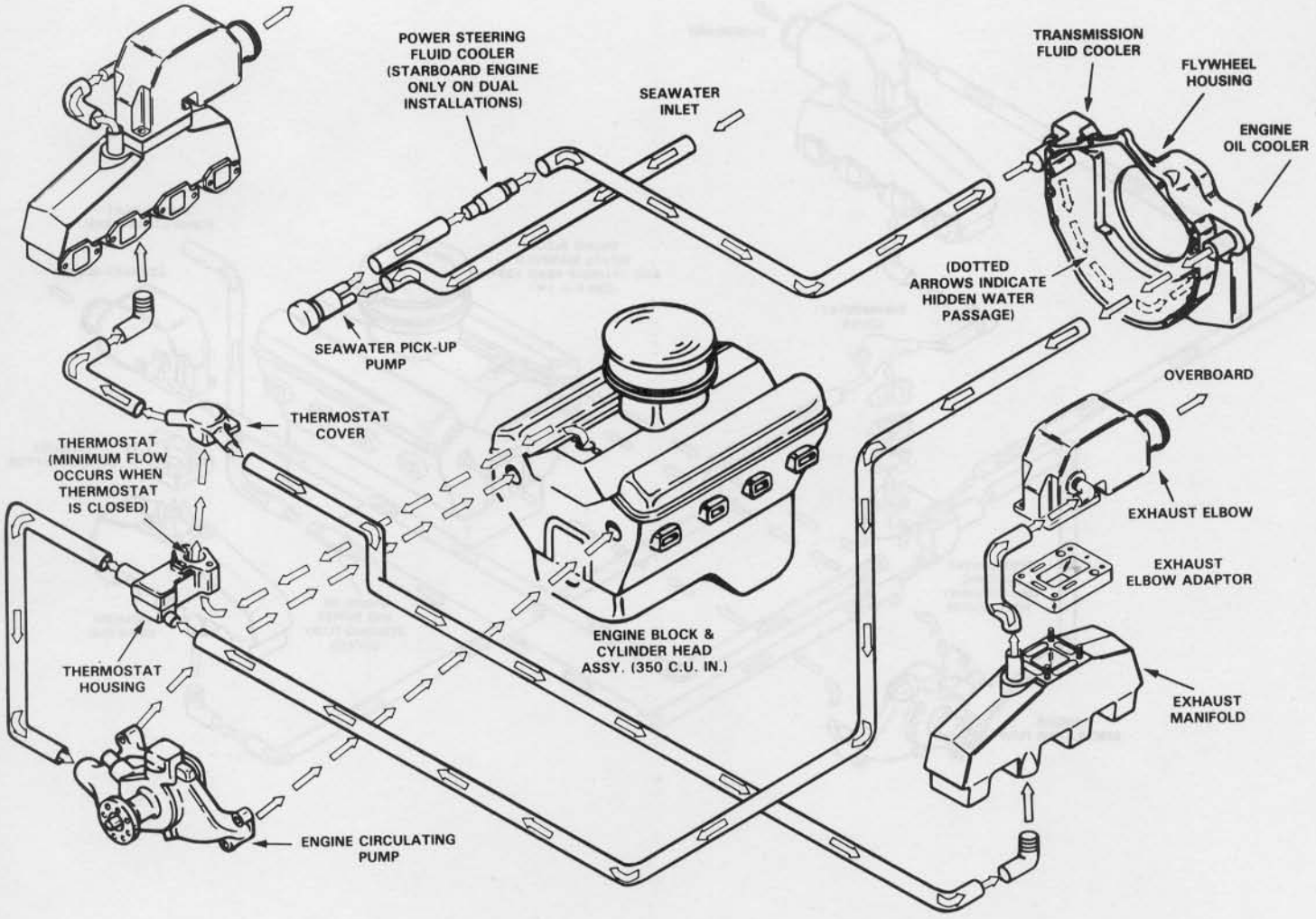


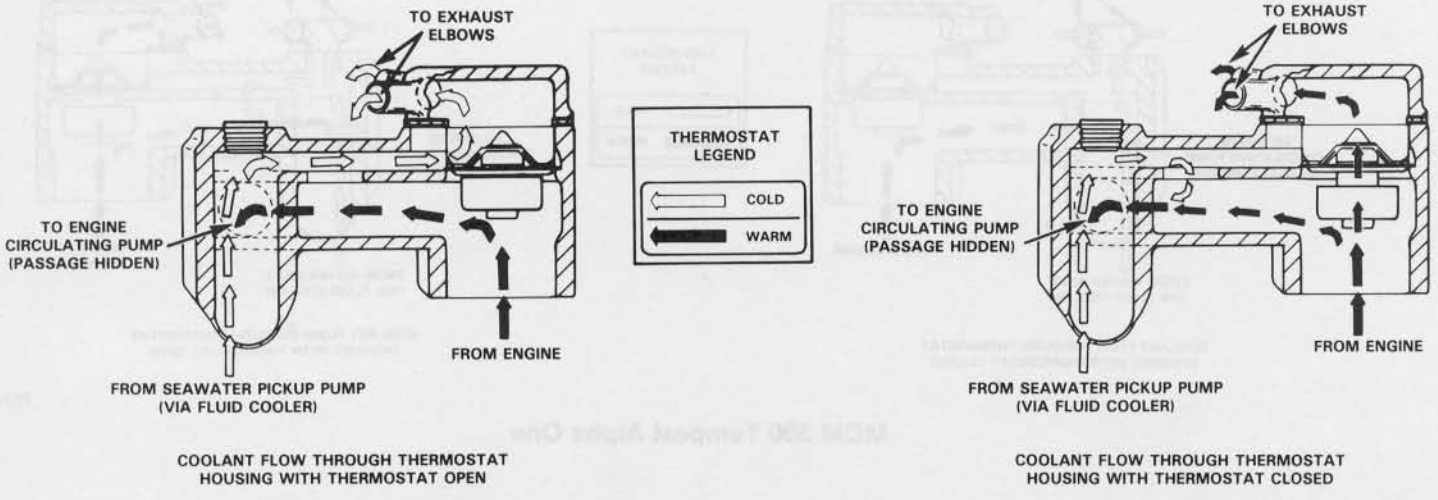
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

727-H

MCM 300 Tempest Alpha One



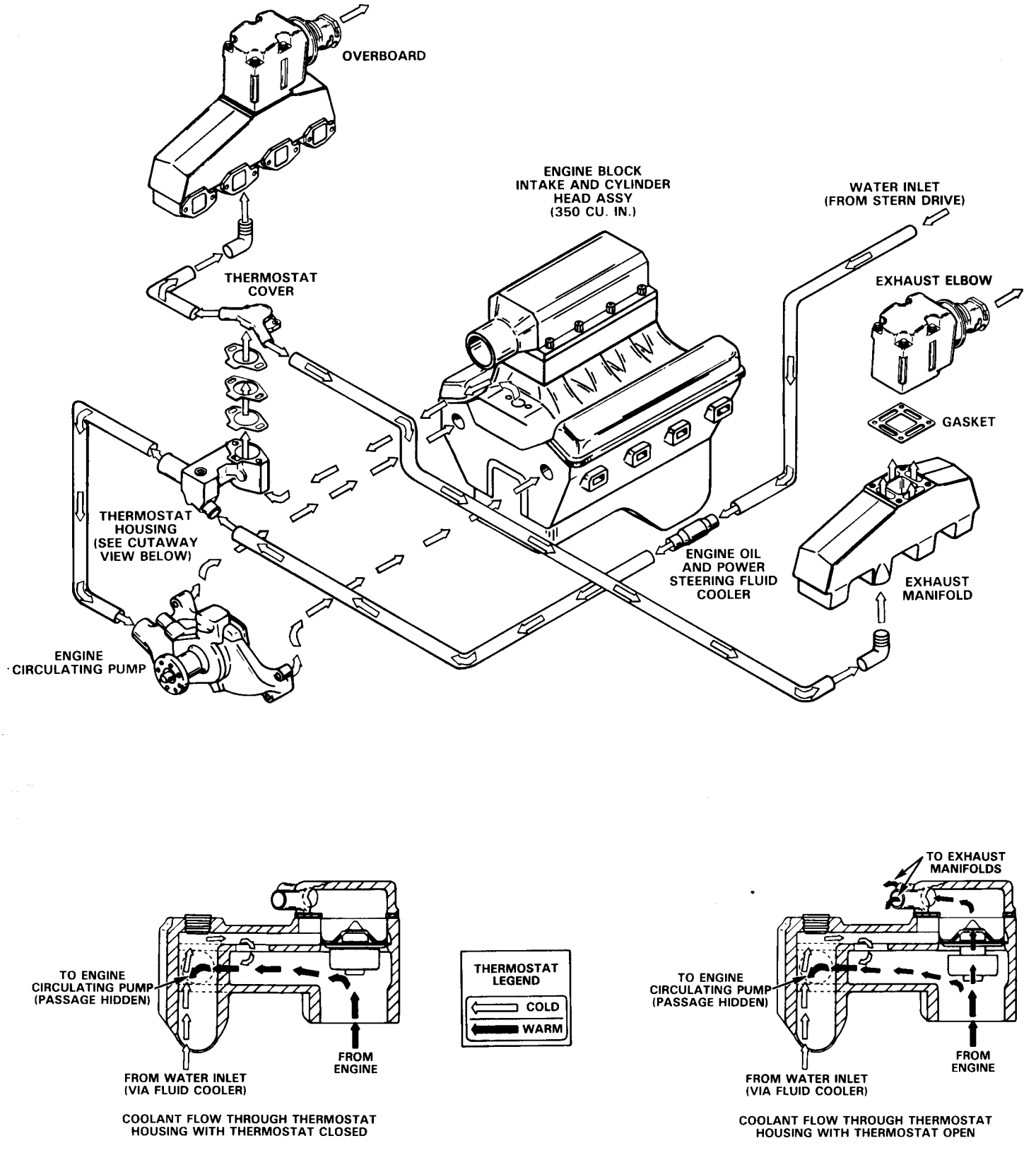


COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

728-H

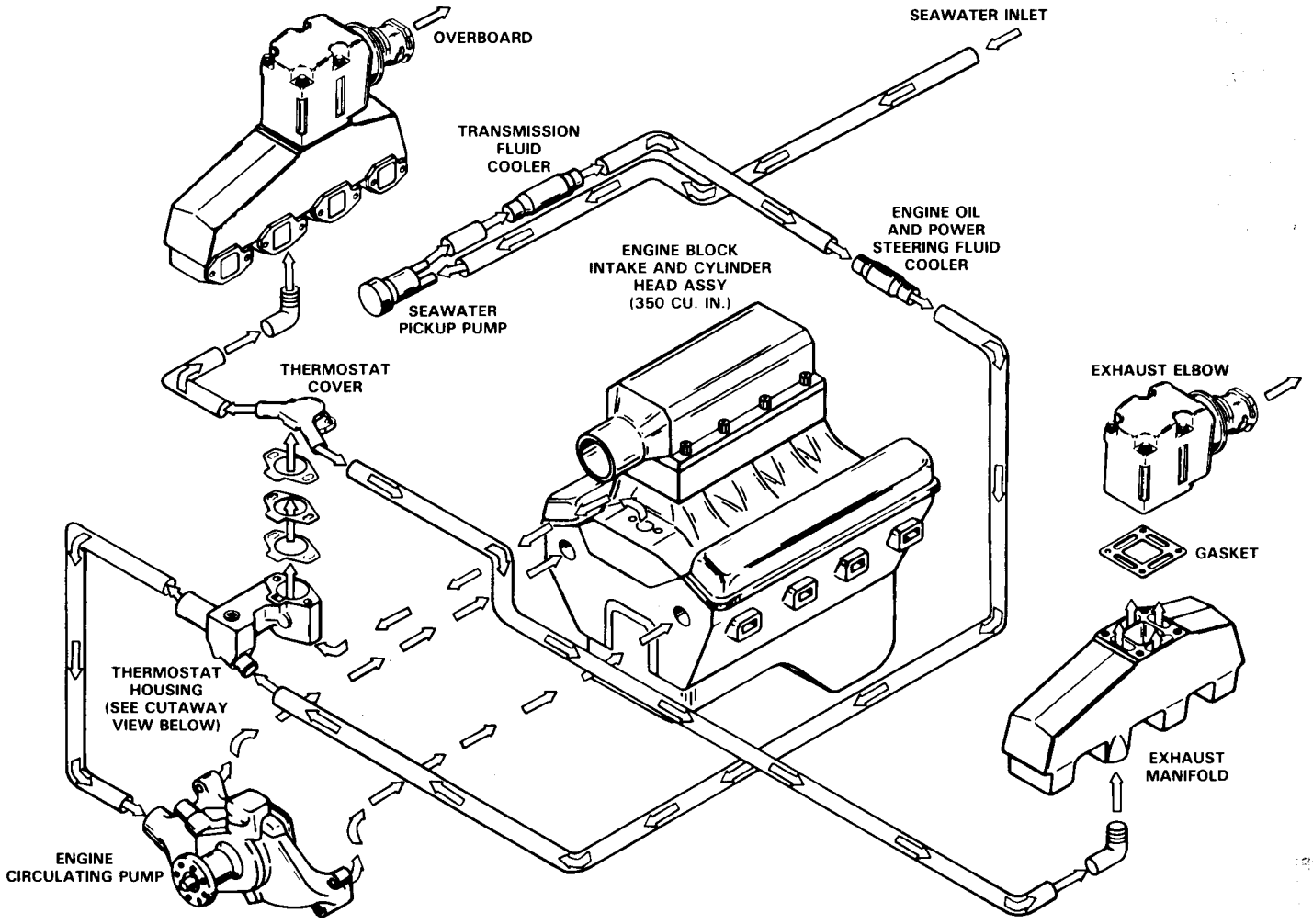
MCM 300 Tempest TRS

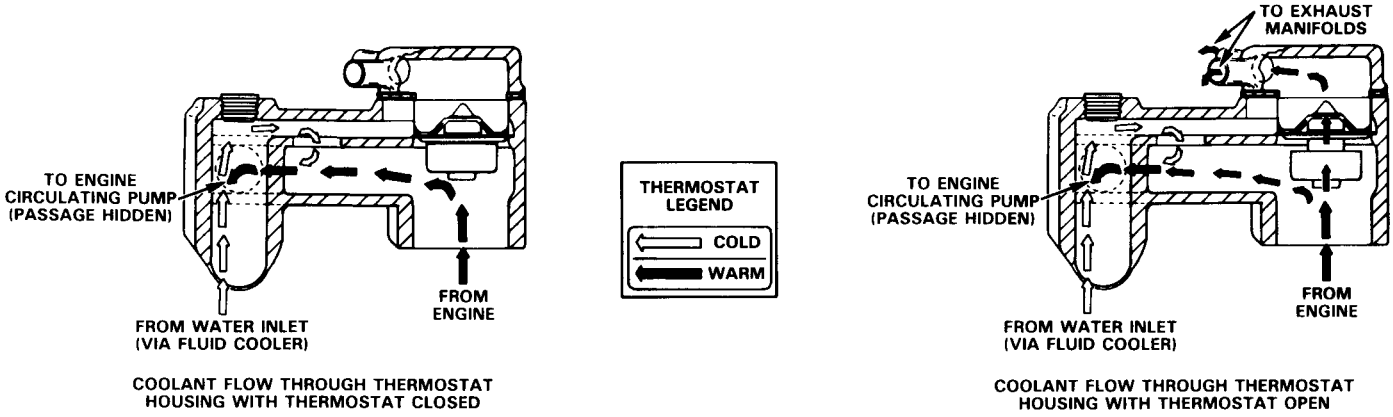


COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

320 EFI Cooling System Flow

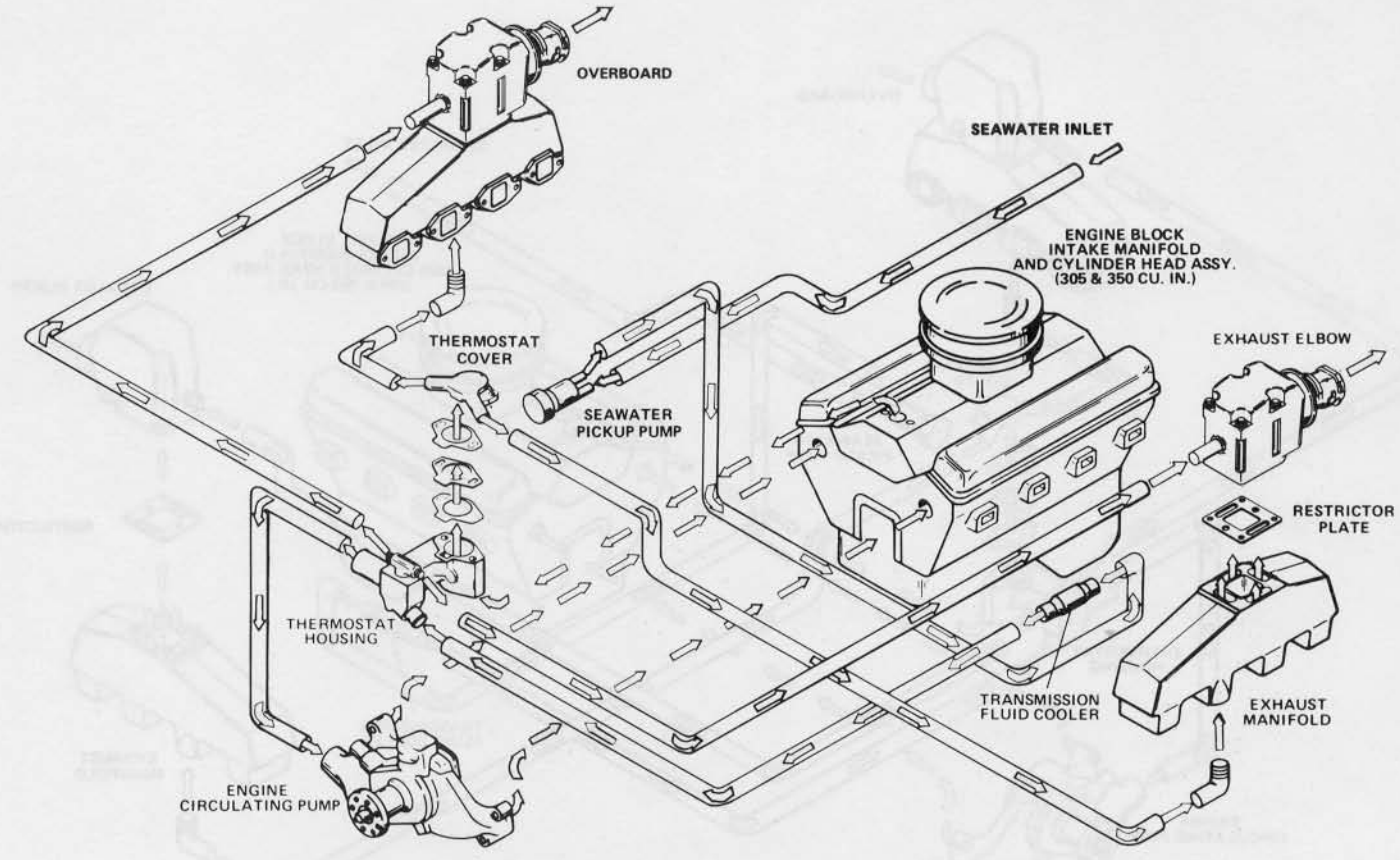


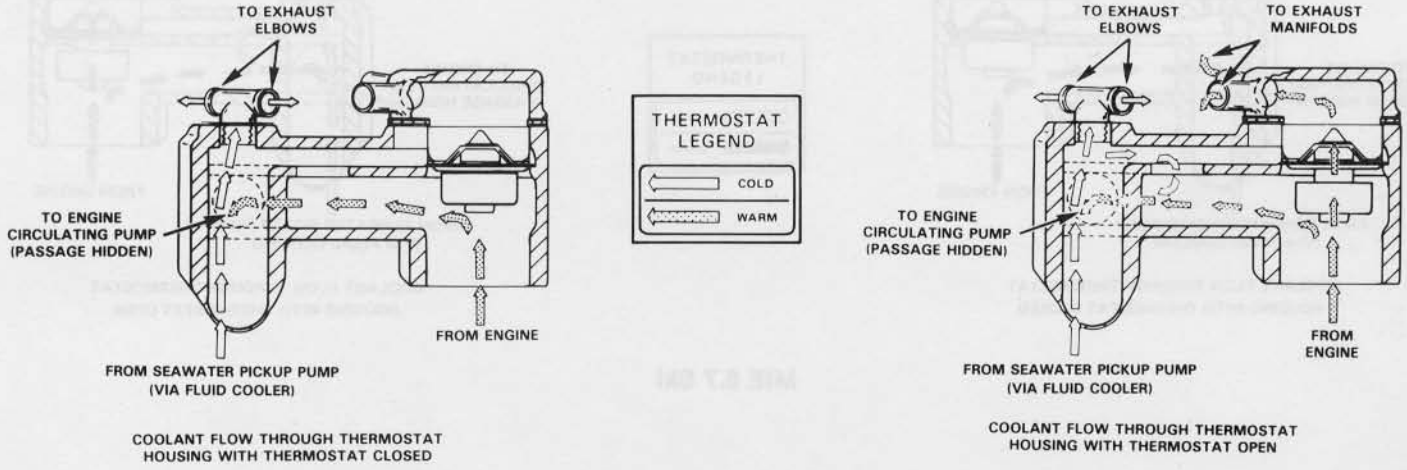


COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

320 EFI Bravo Cooling System Flow



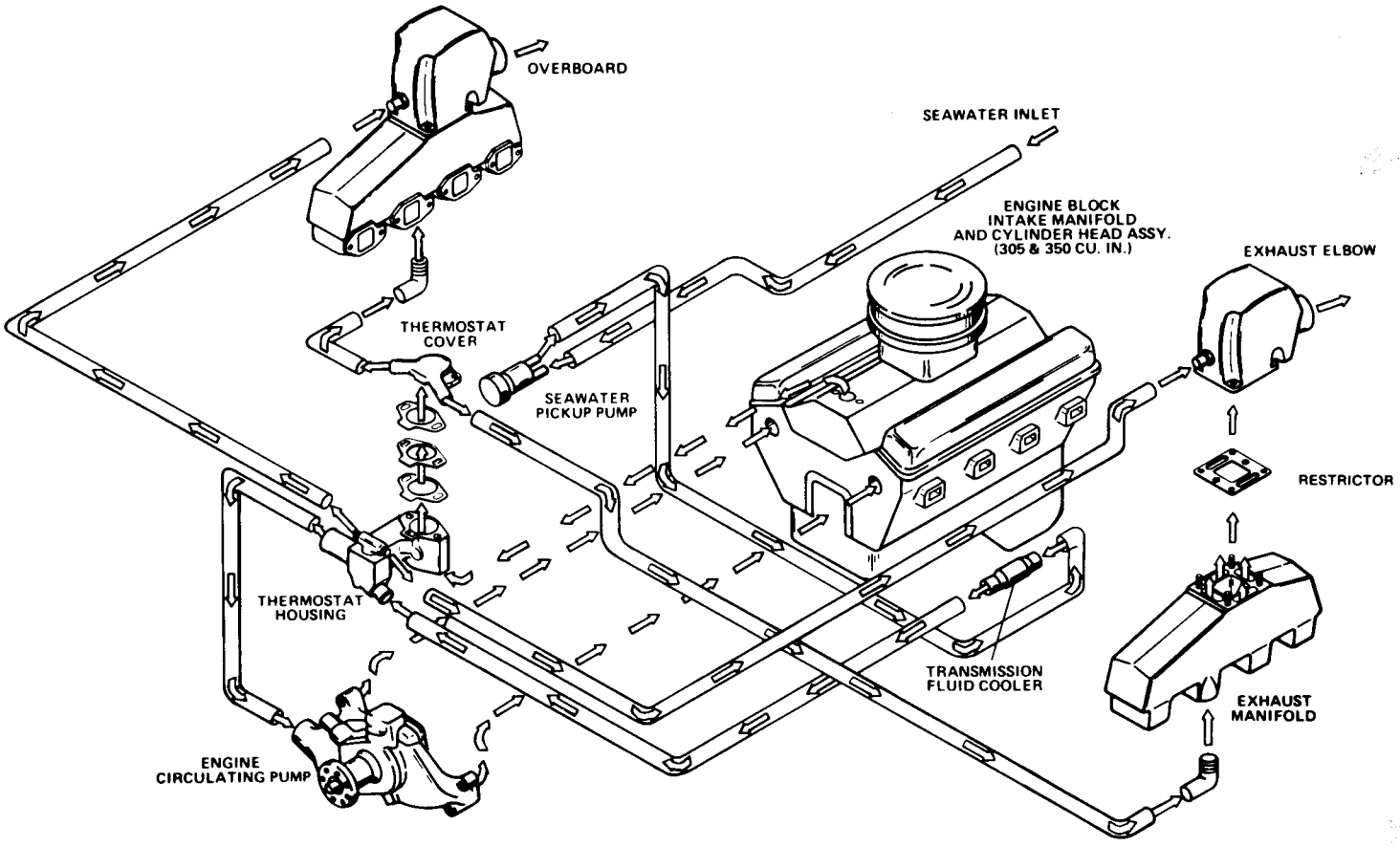


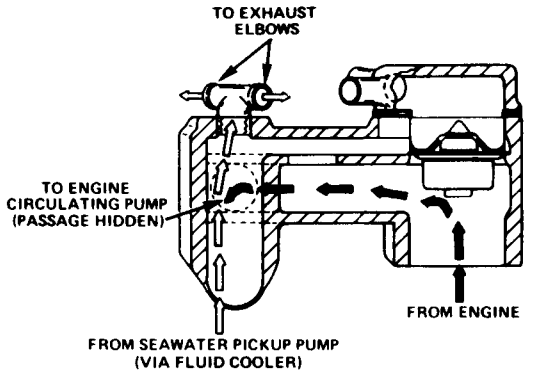
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

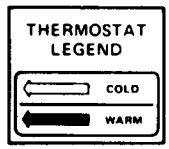
779-H3

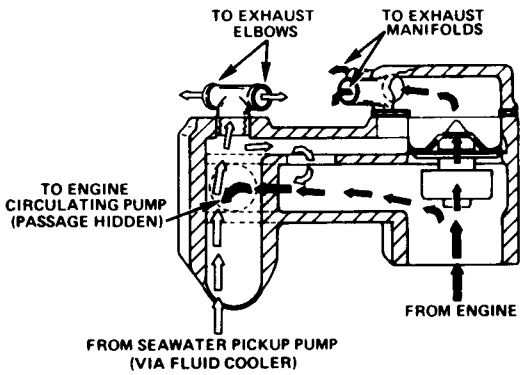
MIE 230/260/5.0 Litre/5.7 Litre





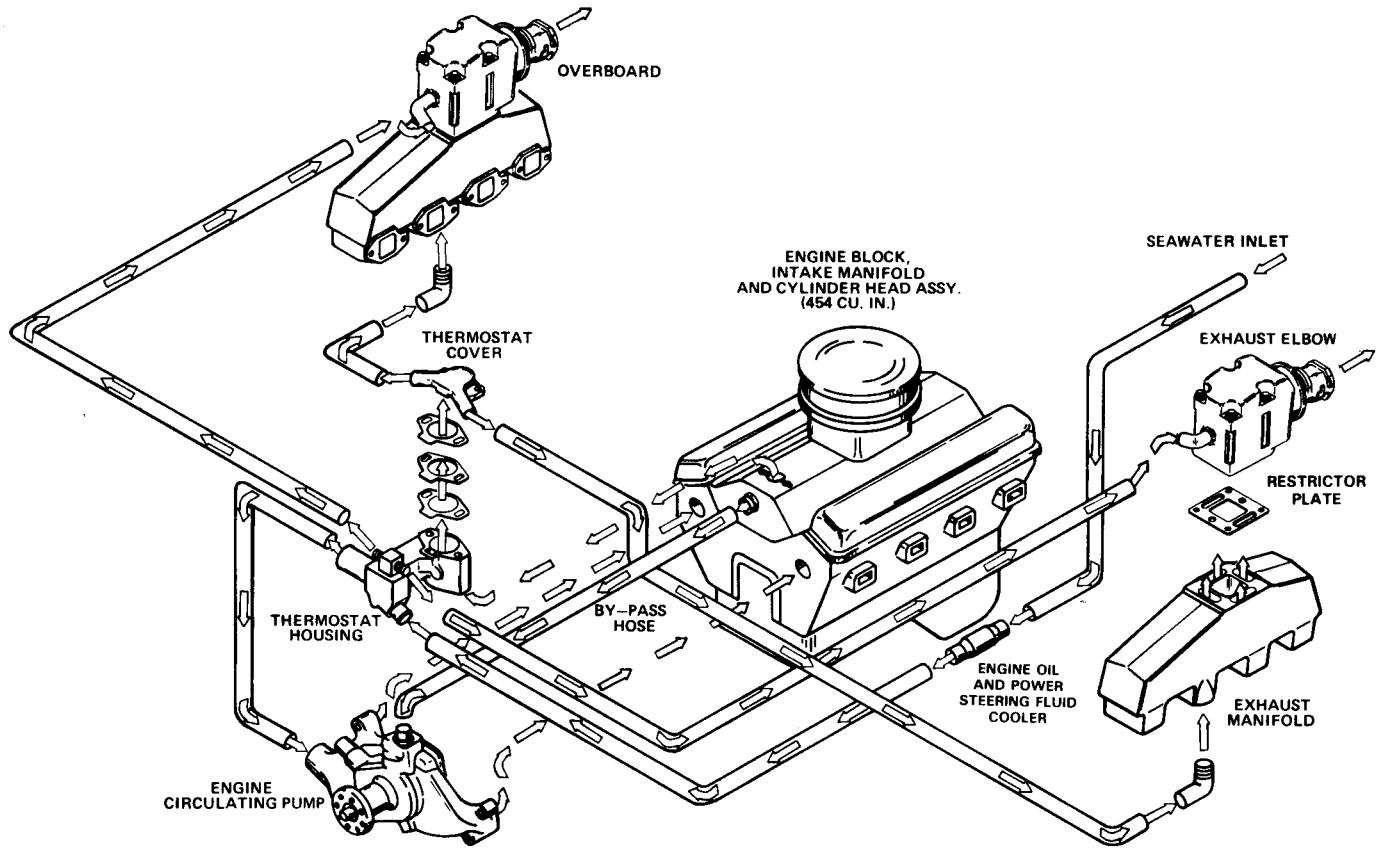
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

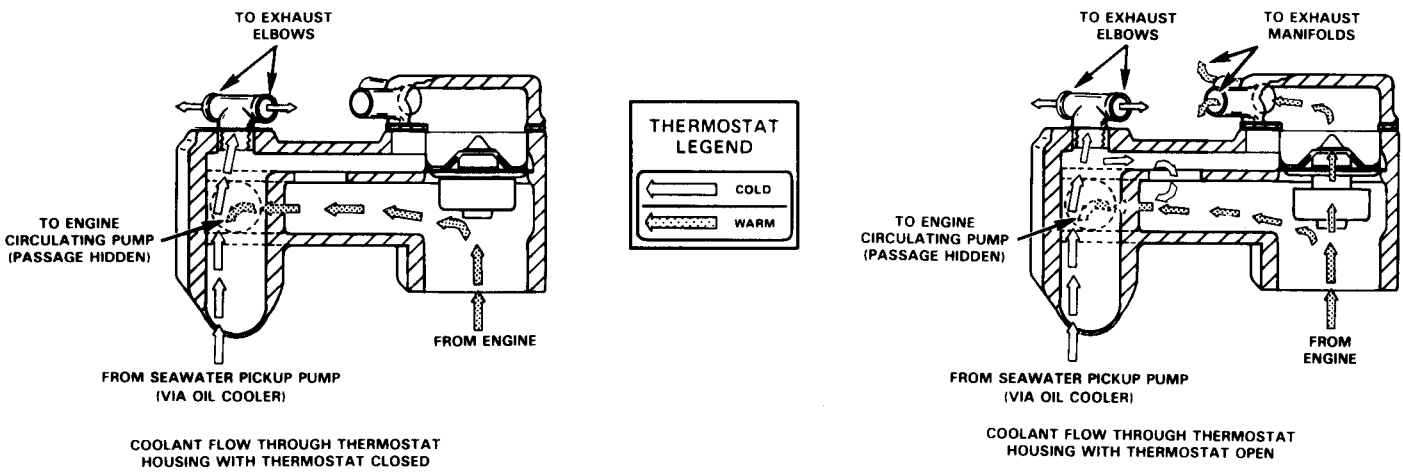




COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

MIE 5.7 Ski



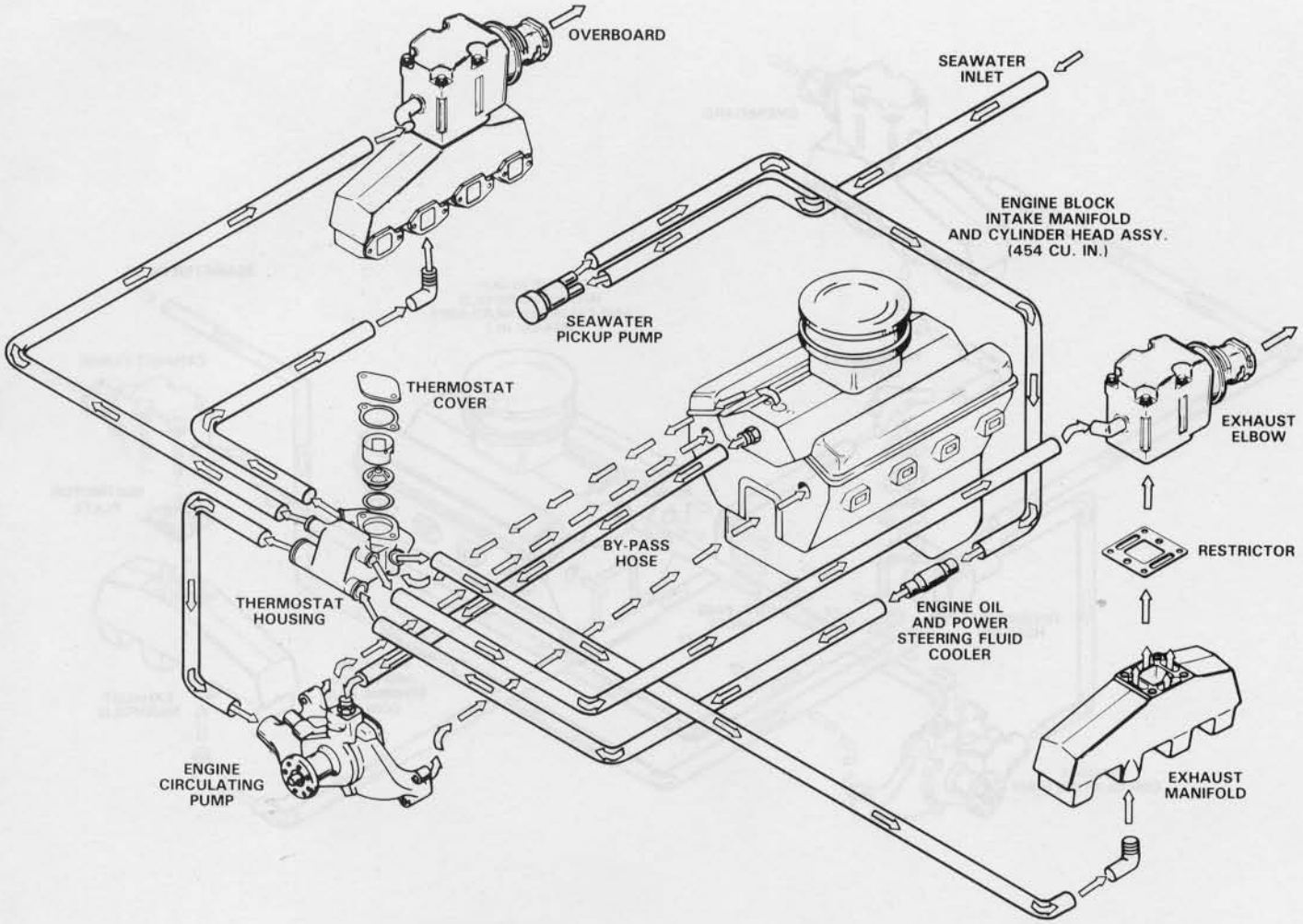


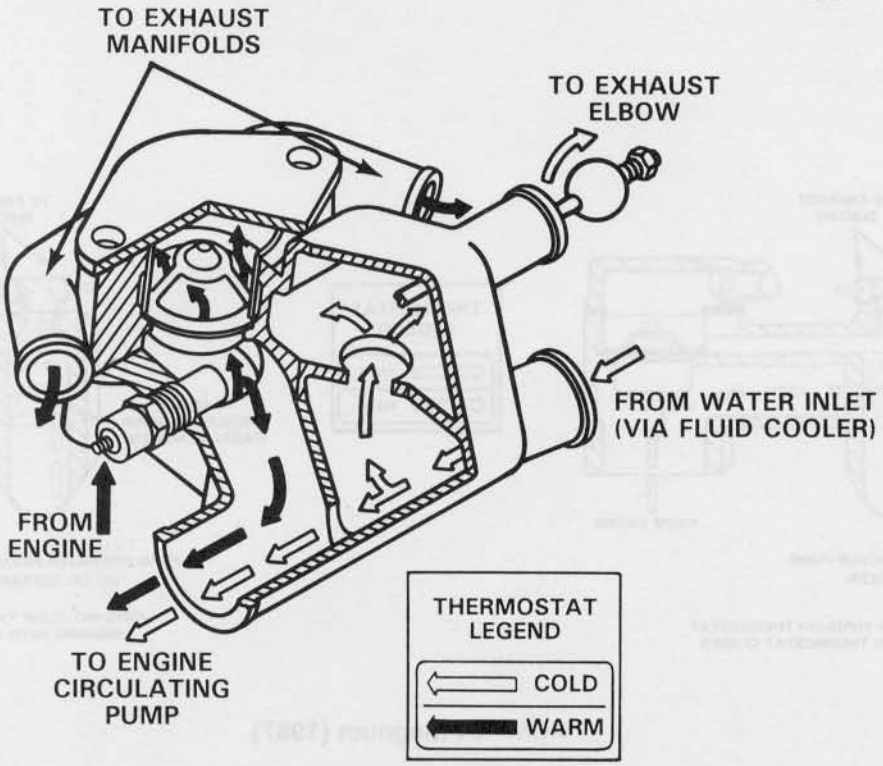
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

857-H

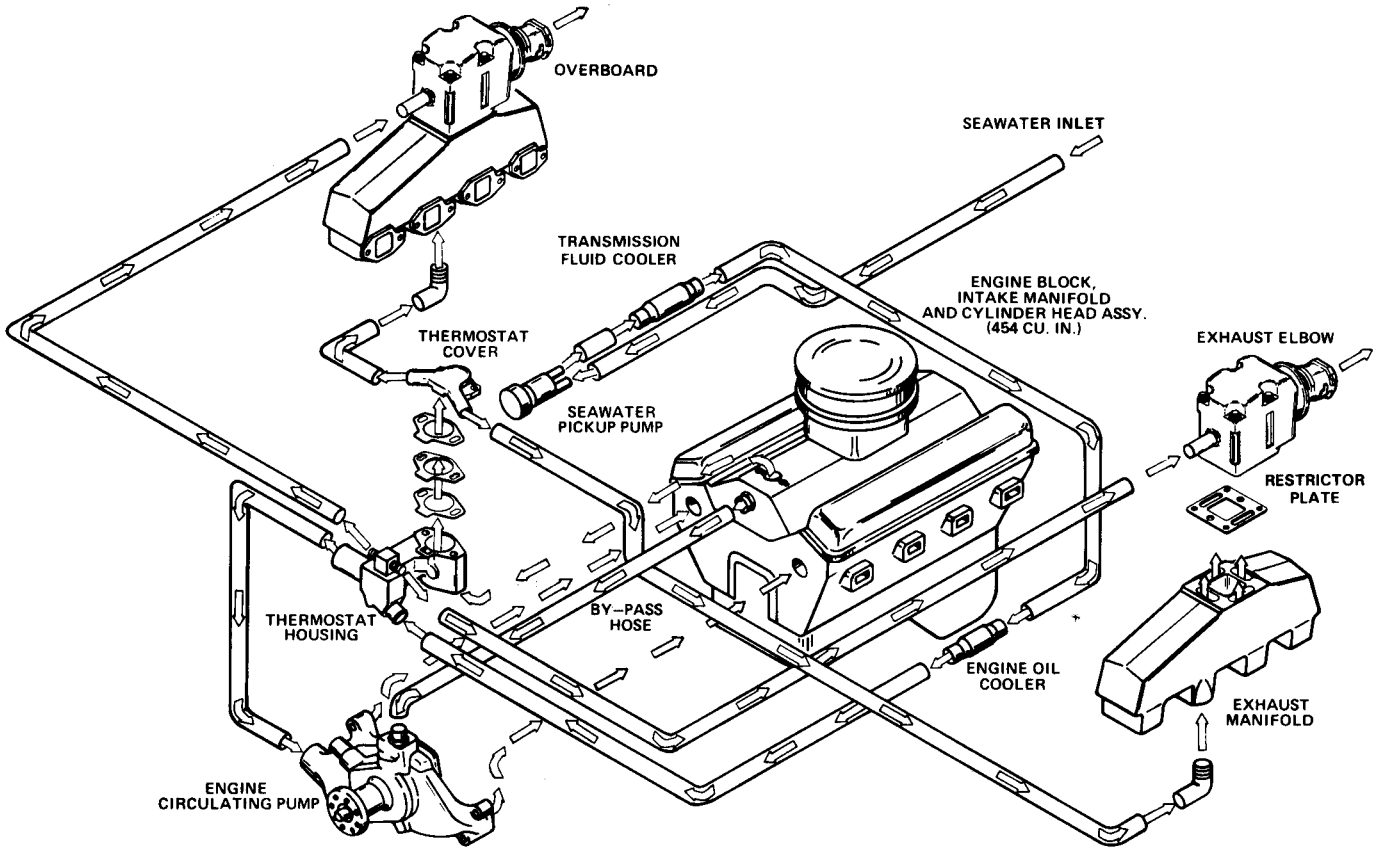
MCM 454 Magnum (1987)

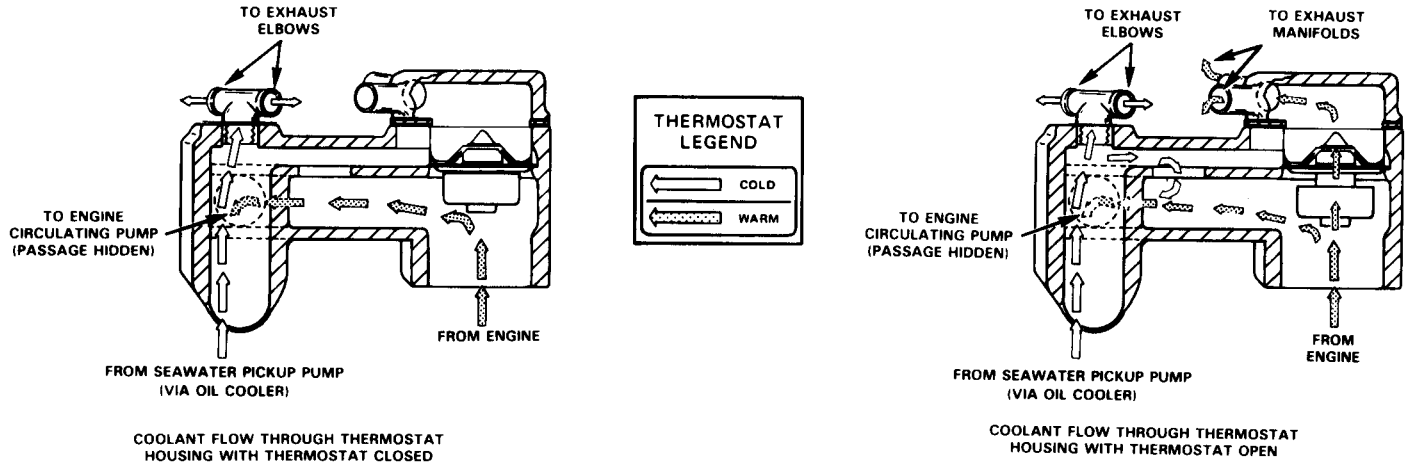




22380

Water Flow Diagram 454 Magnum 1988



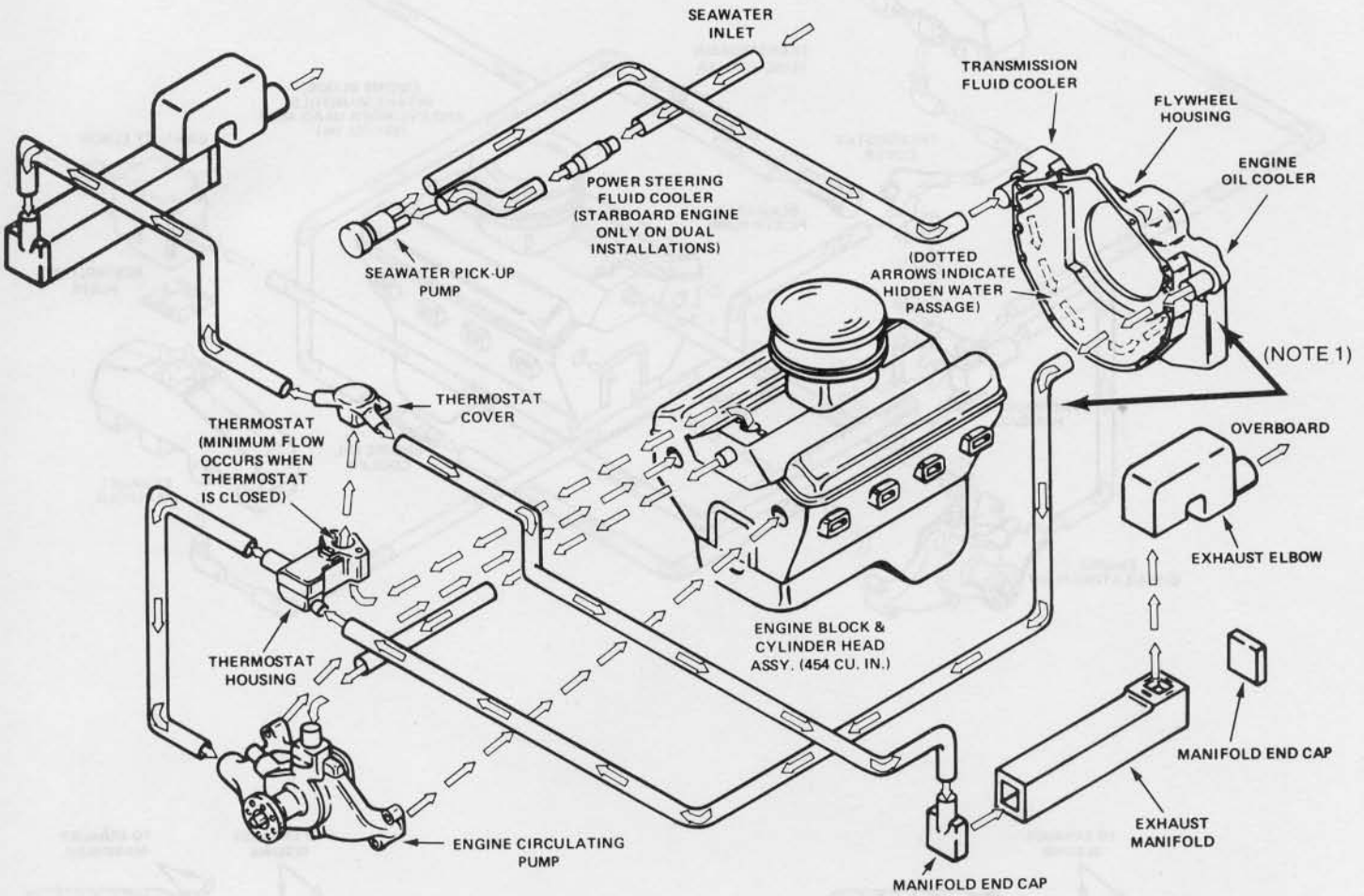


COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

779-H4

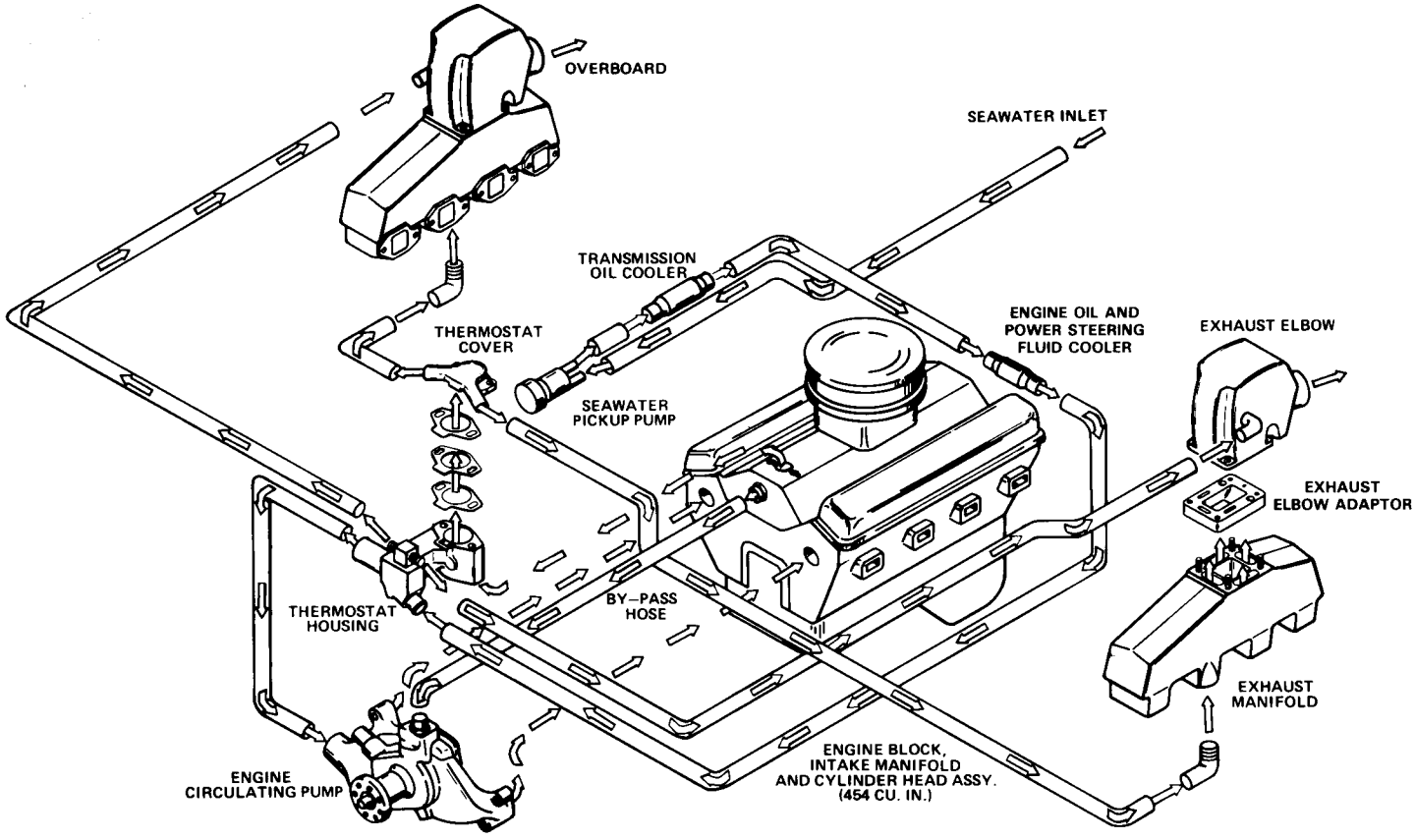
MCM 330 (B-W)/MIE 340/7.4 Litre

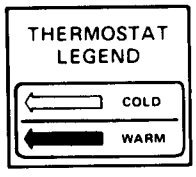


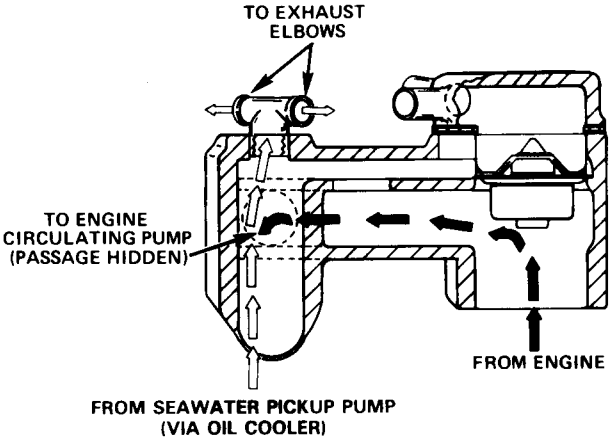
298-H

NOTE 1: Some models did not use the flywheel housing engine oil cooler. A stringer mounted oil cooler was used in the seawater inlet hose. A hose was connected between the transmission fluid cooler and the thermostat housing.

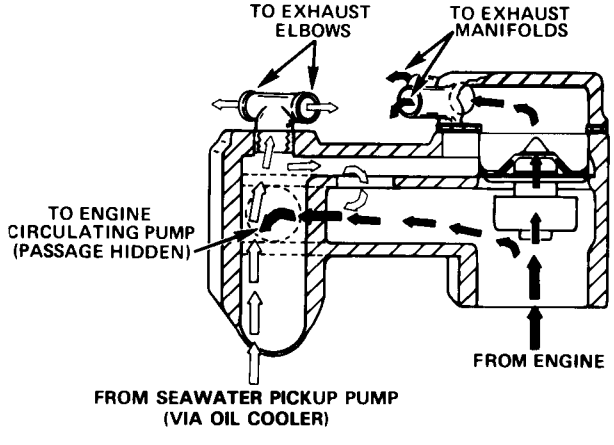
MCM 370TRS/400 Cyclone S/N 6721527 and Below







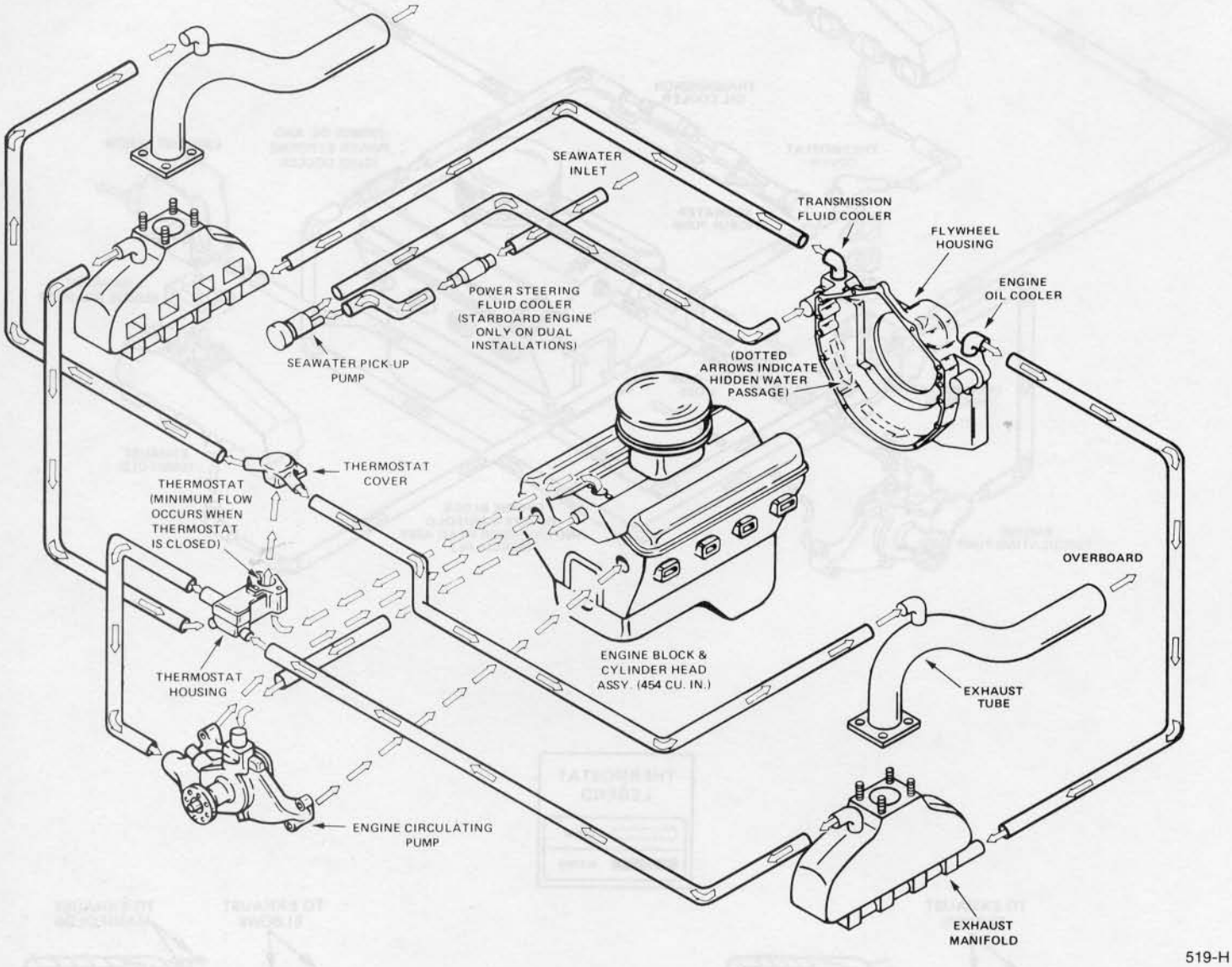
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED



COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

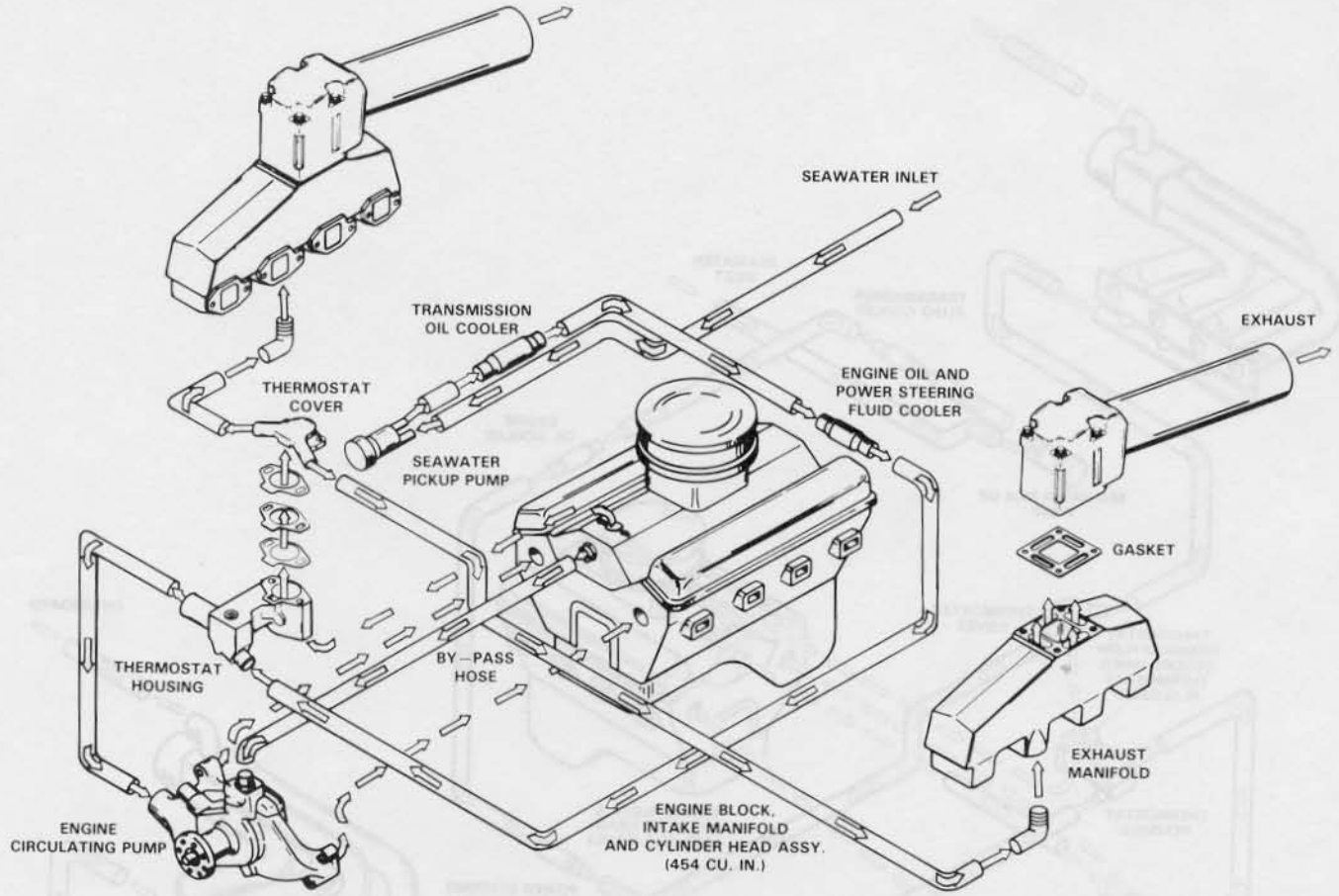
760-H

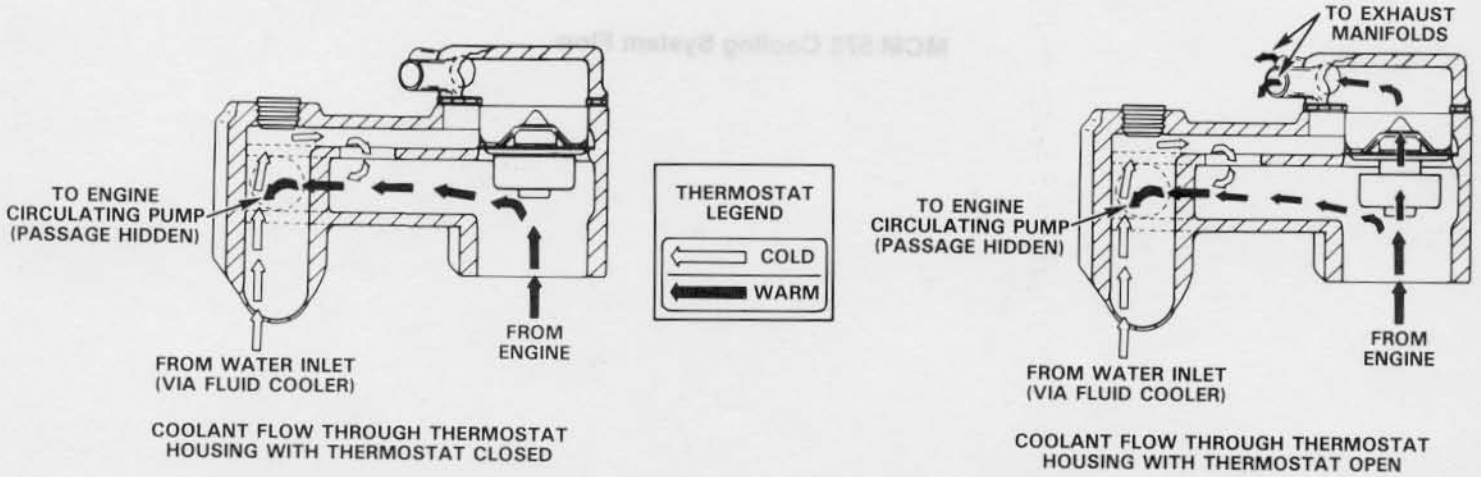
MCM 370TRS/400 Cyclone S/N 6721528 and Above



519-H

MCM 440 Cyclone/460 Cyclone

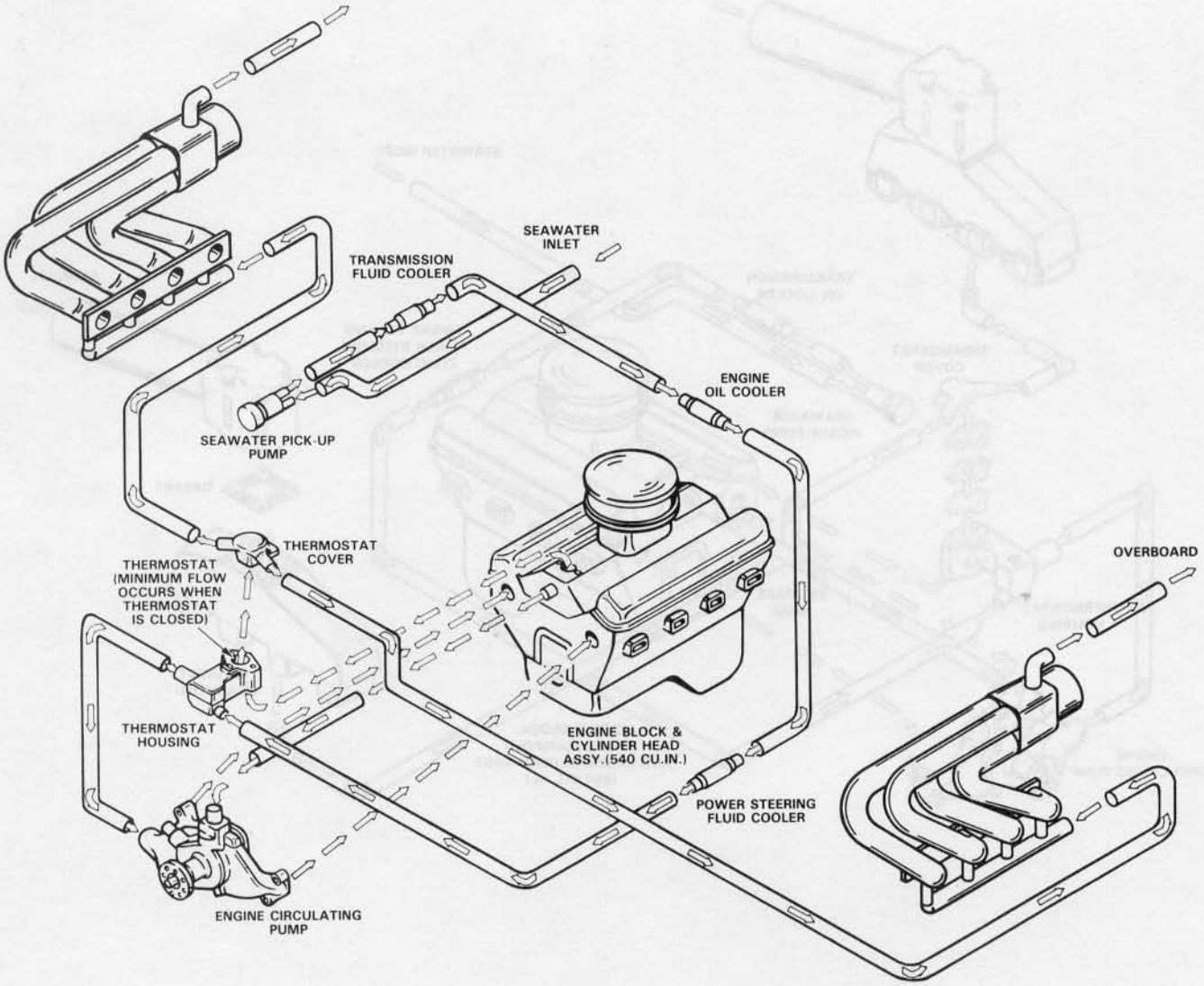




COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED

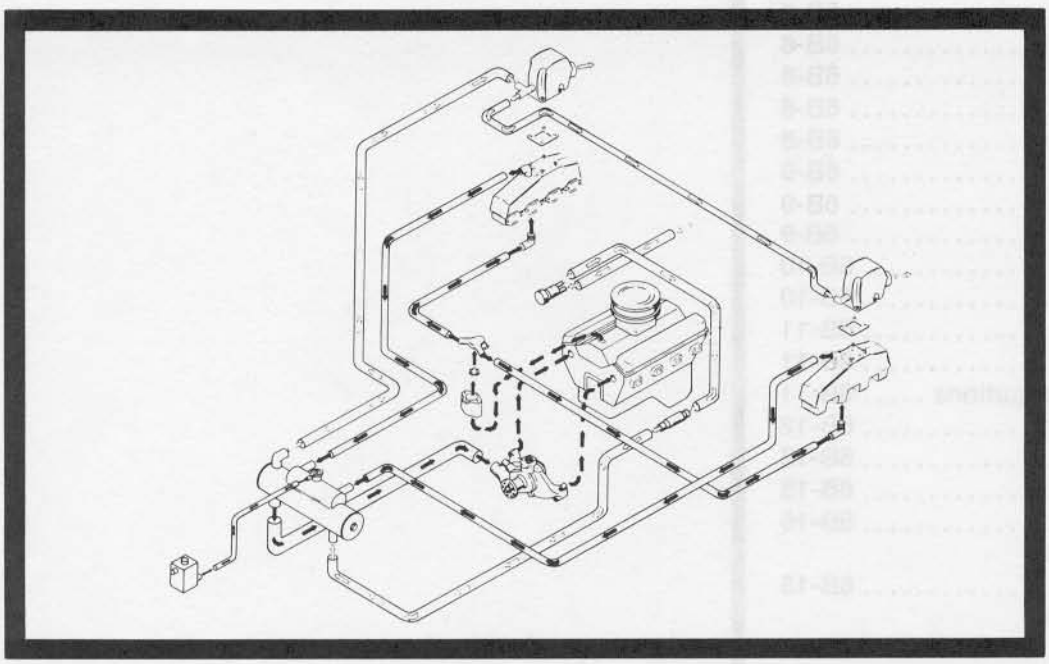
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN

MCM 420 Cooling System Flow



MCM 575 Cooling System Flow

COOLING SYSTEM



CLOSED COOLED MODELS

6

B

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NOTICE

Refer to Section 6, Part A for the following:

- **Seawater Inlet Recommendations**
- **Seawater Pickups**
- **Seawater Pickup Pump Output Test**
- **Stern Drive Unit Seawater Pickup Pump**
- **Belt Driven Seawater Pickup Pump**
- **Water Circulating Pump Replacement**
- **Drive Belt Tension Adjustment**
- **Flushing Cooling System**
- **Auxiliary Hot Water Heater Installation**

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Drain Plugs	Securely	
Heat Exchanger End Cap		36-72 (4-8)
Heat Exchanger Mounting Brackets	Securely	
Hose Clamps	Securely	
Thermostat Cover	30 (41)	

Lubricants/Sealants

LUBRICANTS/SEALANTS	
92-86154A1	Quicksilver 2-4-C Marine Lubricant
92-34227--1	Quicksilver Perfect Seal

Specifications

CLOSED COOLING SYSTEM CAPACITY	
Model	**Qts (litres) Approximately**
MCM/MIE 305/350 CID	20 (19)
MCM/MIE 454/482	28 (26.5)

THERMOSTAT	
All Models	143° F (62° C)

PRESSURE CAP	
All Models	14 PSI (97 kPa)

Description

There are several configurations of this cooling system, but the operation is essentially identical. Basically, the system is composed of two separate subsystems; the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat (from the closed cooling system) as it passes thru the heat exchanger. The closed cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into recovery bottle is approximately 1/2 pint during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there's a vacuum leak, usually at the hose leaving the reservoir, or the gasket under the recovery filler cap. The gasket seals against the outer rim of the filler neck.

IMPORTANT: The coolant (anti-freeze) flows around the outside of the cooling tubes while seawater flows thru the inside of the cooling tubes in the heat exchanger.

All V-8 engine exhaust manifolds are cooled by coolant in the closed cooling system. All V-8 stern drive and inboard engines use a belt driven pump to pump seawater thru the heat exchanger. Water from the seawater pickup pump in the stern drive is used to cool the stern drive only and is then dumped overboard.

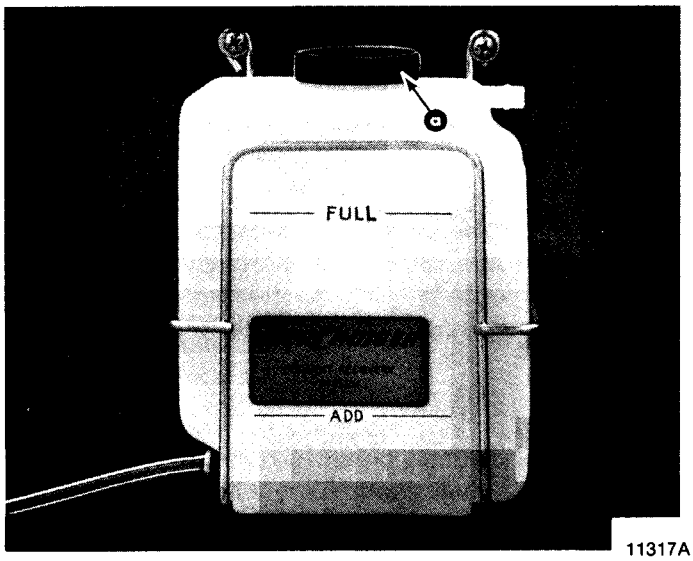
Maintaining Coolant Level

⚠WARNING
Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly then, push down and turn cap all-the-way off.

1. Coolant level in heat exchanger should be within 1" (25mm) from bottom of filler neck.

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stops on filler neck.

2. Coolant level should be between the "Add" and "Full" mark on coolant recovery reservoir with engine at normal operating temperature.



a - Fill Cap

Coolant Recovery Bottle

Testing System

Testing Coolant for Alkalinity

⚠WARNING
Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

1. Obtain pink litmus paper from a local supplier (drug store, pet shop, etc.).
2. Remove pressure cap from heat exchanger and insert one end of litmus paper into coolant.
3. If pink litmus paper turns blue, coolant is alkaline and need not be replaced.
4. If pink litmus paper remains pink, coolant is not alkaline and MUST BE REPLACED.

Pressure Testing System

⚠WARNING
Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

If coolant section of Closed Cooling System is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove pressure cap from heat exchanger or reservoir.
2. Clean, inspect and pressure test pressure cap, as outlined under "Testing Pressure Cap" in this section, to eliminate the possibility that cap is not maintaining proper pressure in system and is causing coolant to boil over.
3. Clean inside of filler neck to remove any deposits or debris. Examine lower inside sealing surface for nicks or other damage. Surface must be perfectly smooth to achieve a good seal between it and rubber seal on cap. Also, check locking cams on sides of filler neck to be sure that they are not bent or damaged. If locking cams are bent or damaged, pressure cap will not hold the proper pressure.
4. Adjust coolant level in fresh water section to 1" (25mm) below filler neck.
5. Attach an automotive-type cooling system pressure tester to filler neck and pressurize closed cooling section to 17 psi (117 kPa).
6. Observe gauge reading for approximately 2 minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leakage is found.
7. While maintaining a pressure of 17 psi on closed cooling section, visually inspect external portion of cooling system (hoses, gaskets, drain plugs, petcocks, core plugs, circulating pump seal, etc.) for leakage. Also listen closely for bubbling or hissing, as they usually are a sure indication of a leak.
8. Test Heat Exchanger, as outlined.

9. If no leakage could be found in above steps, engine is leaking internally, and it probably is due to one or more of the following: 1) Loose cylinder head bolts or damaged gasket, 2) loose intake manifold bolts or damaged gasket, 3) loose exhaust elbow or distribution block retaining nuts or damaged gasket, 4) cracked or porous cylinder head or block, 5) cracked or porous exhaust manifold. Proceed as follows until location of internal leak is found-

   a. Start engine. Repressureize system to 17 psi and observe pressure gauge on tester. If needle in gauge vibrates, compression or combustion is leaking into closed cooling section from a leak in the combustion chamber. Exact cylinders, where leakage is taking place, sometimes can be found by removing spark plug wires (one at a time) while observing pressure gauge. Vibration will decrease or stop when plug wire is removed from leaking cylinder. Stop engine.

   b. Remove spark plugs (one at a time) from cylinders and examine for presence of coolant. A spark plug, that is perfectly clean or milky appearing, is a sure indication of a leak.

   c. Drain oil from engine and examine for presence of coolant. Oil usually will be milky, if coolant is present. If coolant is present, remove engine from boat and drop the oil pan. With engine in the upright position, repressurize closed cooling section to 17 psi and examine internal surfaces of engine to locate leak.

   d. If no leakage can be found in above steps, entire engine must be disassembled and inspected for leakage.

Testing for Cylinder Head Gasket Leak

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor; and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures which cause the leak. An effective test is as follows:

IMPORTANT: Run boat in lake for this test. It is best to run the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and coolant recovery bottle. Use a 2-3 ft. (61-91cm) long hose for this test.
2. Route this hose so a "U" is formed.
3. Put enough coolant into hose to fill the center 4 or 5 inches (10-13cm) of the "U".
4. Observe the "U" while the engine is running.

   a. During idle and warm-up: some coolant and/or air will leave the reservoir.

   b. During cruising speed (2500-3500 RPM); coolant and/or air leaving the reservoir should stop after approximately 5 minutes running at a given RPM. A leaking head gasket will produce air bubbling through the "U", going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.

   c. At higher speeds (4000 + RPM): Normal operation is the same as described in "b" above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

It is important not to confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant which will stop within approximately 5 minutes at a given RPM. A head gasket leak will not stop - the one thing that marks a failed head gasket is the continued passage of air, that may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant continues to flow (not in violent, intermittent bursts) from the reservoir at cruising speed, something else besides the head gasket is causing the engine to overheat.

Testing Heat Exchanger

For Internal Leak: An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

a. Remove a seawater hose from the exchanger. Do not drain the exchanger.

b. Pressurize the closed cooling circuit to 14-20 PSI (97-138 kPa) with a radiator tester.

c. If seawater begins to flow from the nipple there is a leak.

For Blockage:

IMPORTANT: Seawater flows THROUGH the tubes in the exchanger. Closed cooling coolant flows AROUND the tubes.

a. Remove end caps and inspect for any blockage in the seawater circuit (broken impeller blades, weeds, etc.).

b. Remove closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

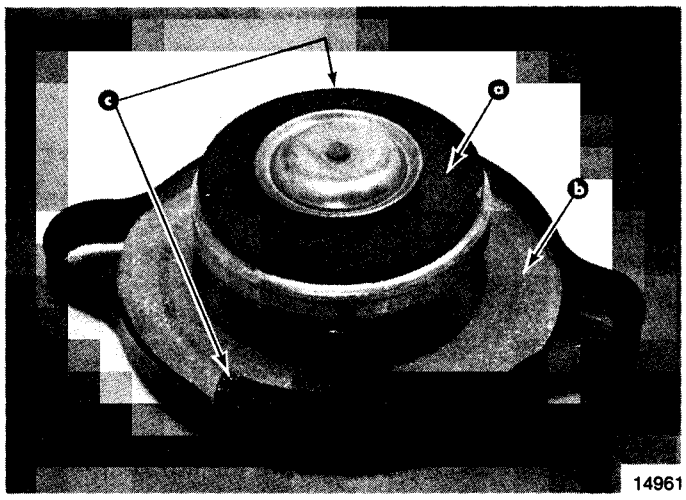
Testing Pressure Cap

Pressure cap is designed to maintain a pressure of approximately 14 psi (97 kPa) in closed cooling section once engine has attained operating temperature. Cap should be cleaned, inspected and pressure-tested at regular tune-up intervals or whenever cap is suspected of maintaining improper pressure, as follows;

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

1. Carefully remove pressure cap from reservoir or heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect gasket (if used) and rubber seal on cap for tears, cuts, cracks or other signs of deterioration. Replace gasket, if damage, or entire cap, if rubber seal is damaged.



14961

a - Rubber Seal (Cap MUST BE Replaced if damaged)
b - Gasket (Look for Cracks under Gasket)
c - Locking Tabs (1 Hidden)

Pressure Cap

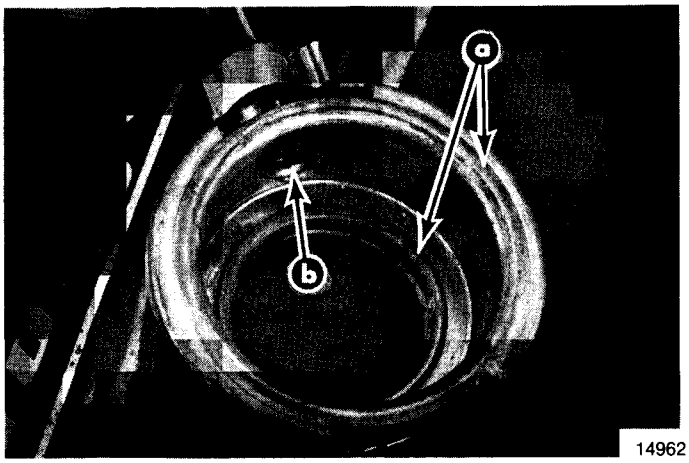
4. Check that locking tabs on cap are not bent or damaged.
5. Using a cooling system pressure tester (similar to one shown), test cap to be sure that it releases at proper pressure and does not leak. (Refer to instructions which accompany tester for correct test procedure.) Cap must relieve pressure at 14 psi (97 kPa) and must hold rated pressure for 30 seconds without going below 11 psi. Replace cap if it fails to fall within these limits.

06054

Pressure Testing Pressure Cap

IMPORTANT: Before reinstalling cap in next step, examine lower inside sealing surface in filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect cam lock flanges on sides of filler neck to be sure that they are not bent.

6. Reinstall cap on reservoir or heat exchanger.



14962

a - Inspect for Damage
b - Clean Coolant Recovery Passage

Heat Exchanger

Heat Exchanger Repair

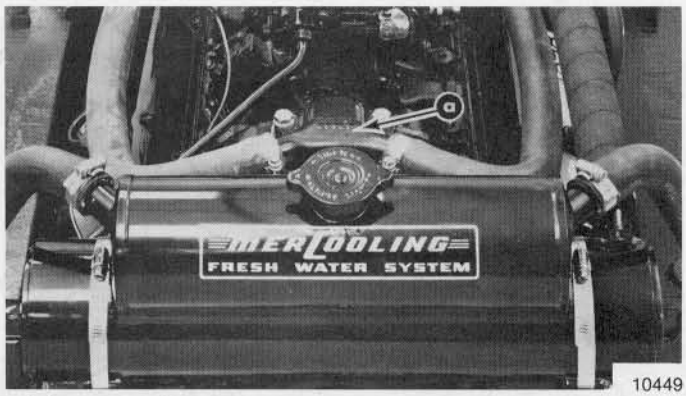
IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.

1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in cooling capacity. Do not close more than 3 tubes.
2. Nipples and drains, that have been broken off the heat exchanger, can be re-attached by brazing.

Thermostat

Removal

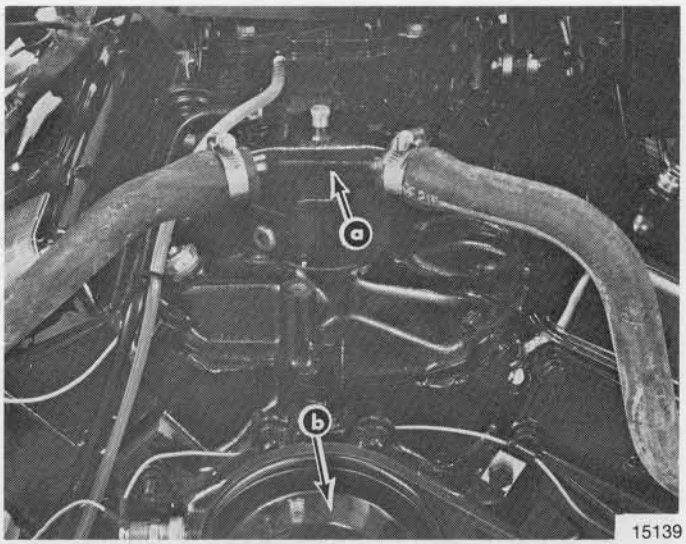
1. Drain coolant from cylinder block and exhaust manifolds.
2. Disconnect hoses from thermostat cover.
3. Remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket.
4. Remove thermostat from thermostat housing.



10449

a - Thermostat Cover

Models Without "T" Fitting in Cover



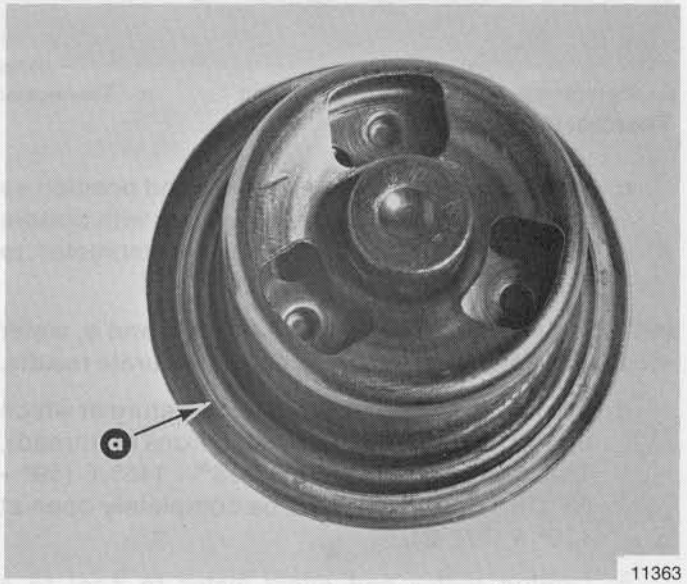
15139

a - Thermostat Cover
b - Circulating Pump

Models With "T" Fitting in Cover

Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to a lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or 2 points around the valve perimeter is acceptable.)



11363

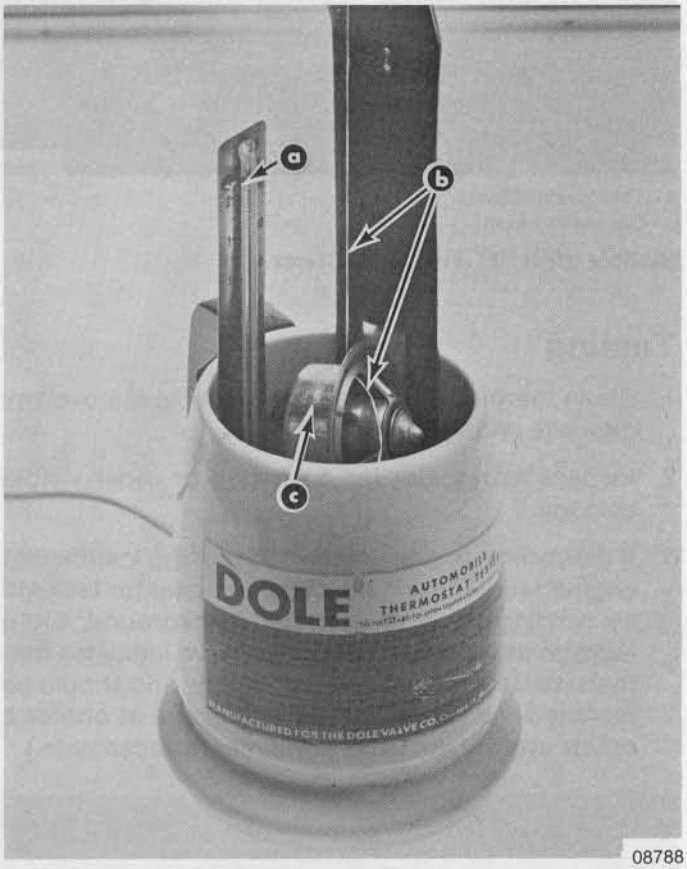
a - Check for Light Leakage Around Perimeter of Valve

Checking Typical Thermostats for Leakage

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown, as follows:

   a. Fill tester to within 1" (25mm) of top with tap water. Do not use distilled water.

   b. Open thermostat valve and insert thread. Position thermostat on nylon string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.



08788

a - Thermometer b - Nylon String c - Thermostat

Thermostat Tester

   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.

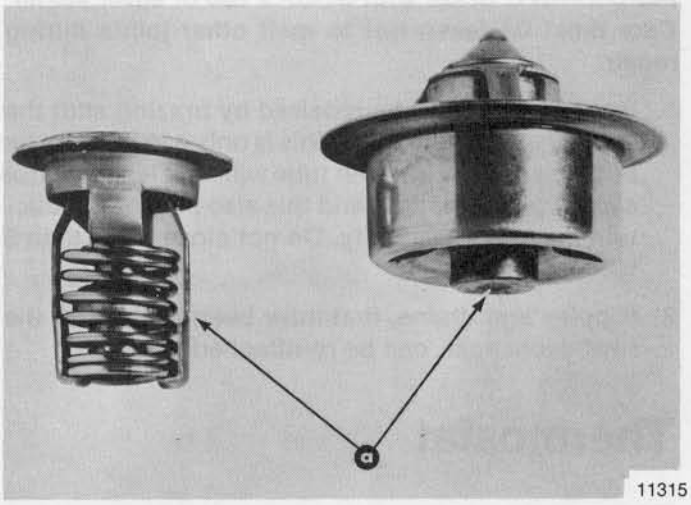
IMPORTANT: When performing Steps d and e, water must be agitated thoroughly to obtain accurate results.

   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at 138° - 145° F (59° - 63° C). Thermostat must be completely open at 170° F (77° C).

   e. Unplug tester and allow water to cool to a temperature 10° F (5° C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.

   f. Replace a thermostat that fails to meet all of the preceding tests.

Installation



11315

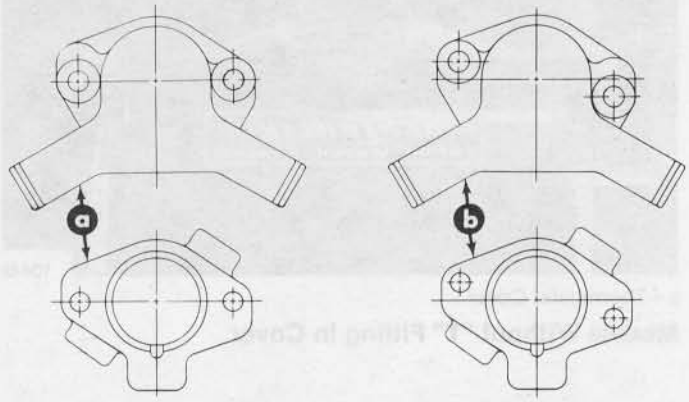
a - Install Thermostat with This End Toward Thermostat Housing

Typical Thermostat Installation

⚠CAUTION

Do not operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged.

The thermostat housings and covers are made from the same basic castings. However, the drilled holes, for mounting the assemblies to the intake manifold, are in different locations for the small block and large block V-8 engines. Refer to figure below for correct location of mounting holes in the different assemblies.



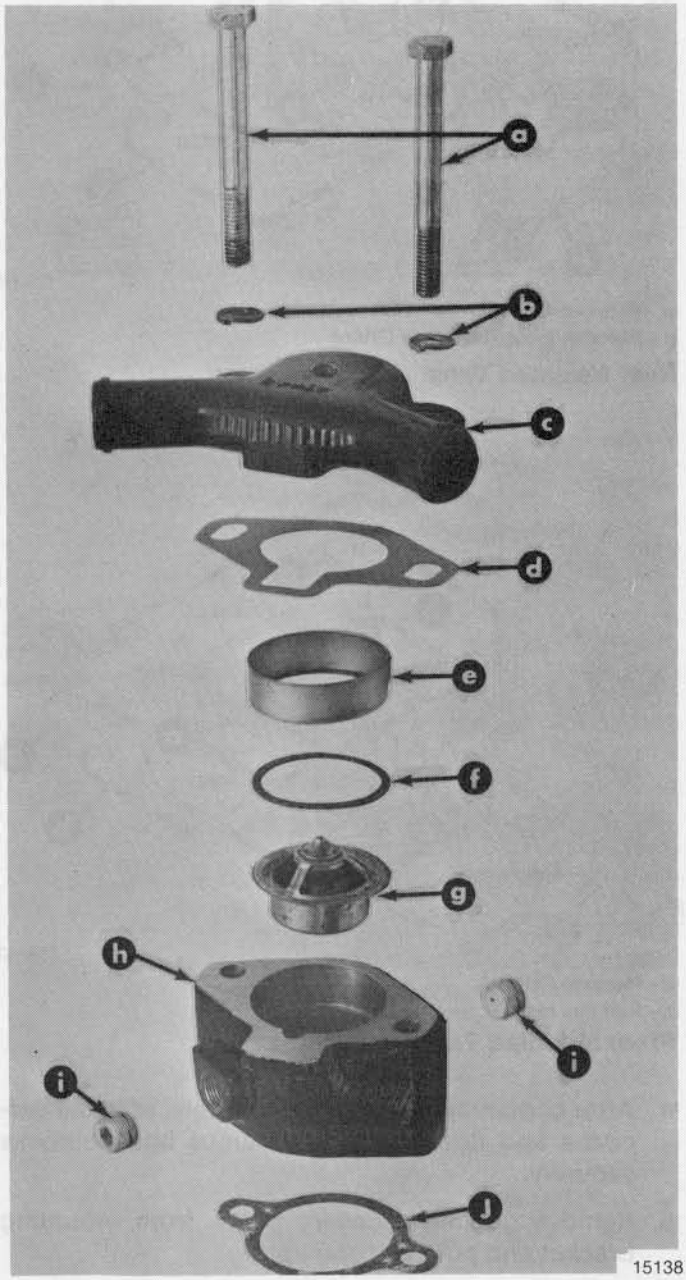
a - 305/350 CID V-8 Engine b - 454 CID V-8 Engine

Location of Mounting Holes in Thermostat Housing and Cover Assemblies

1. Remove thermostat housing and gaskets. Discard gaskets.
2. Clean gasket surfaces on thermostat cover, thermostat housing and intake manifold.
3. Coat both sides of new thermostat housing to intake manifold gasket (without continuity rivets), with Perfect Seal, then position gasket and thermostat housing on manifold.

IMPORTANT: If gasket has continuity rivets, do not coat with Perfect Seal or Audio Warning temperature switch may not work properly.

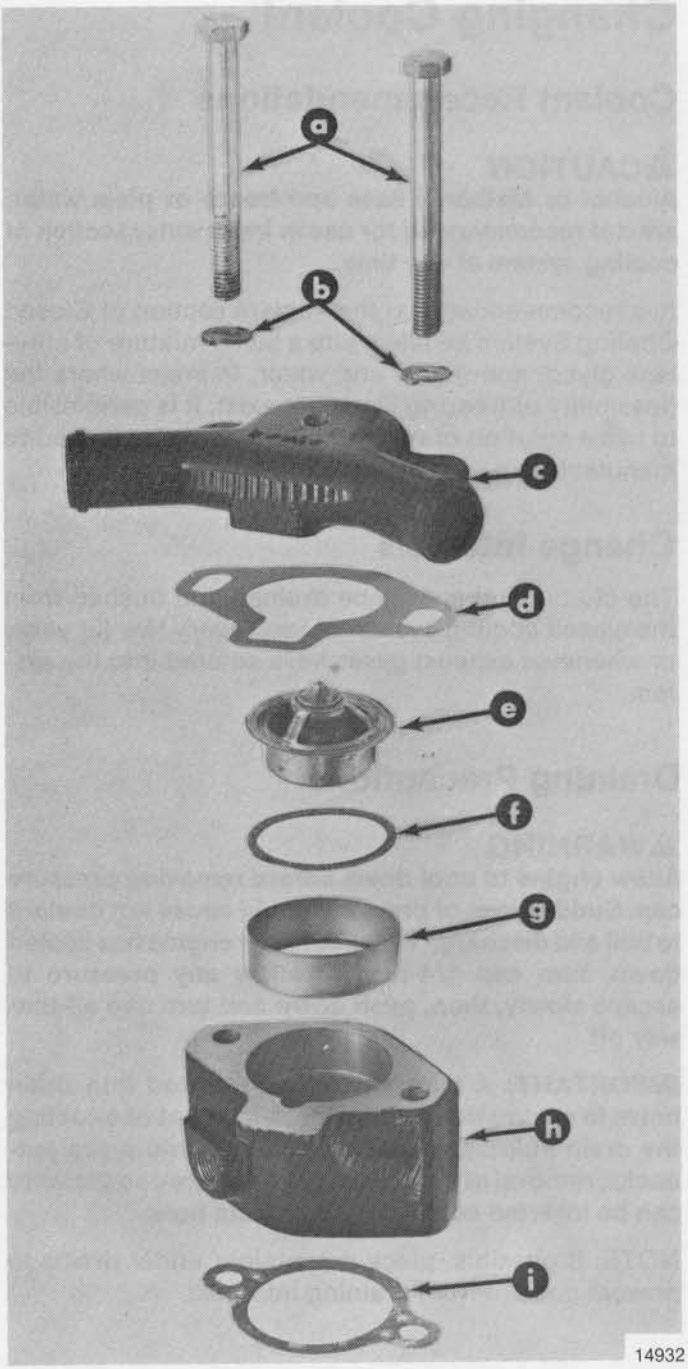
4. Place thermostat, new cork gasket and retaining sleeve in thermostat housing, as shown.
5. Coat both sides of new thermostat cover gasket with Perfect Seal, then position gasket on thermostat housing and reinstall thermostat cover. Torque bolts to specifications.
6. Reconnect hoses to thermostat cover.
7. Refill Closed Cooling System with coolant, as outlined in "Changing Coolant", see Index.



15138

a - Bolts (Torque to Specifications)
b - Lockwashers
c - Cover
d - Gasket (Coat with Perfect Seal)
e - Sleeve (Install with Turned-In Edge Down)
f - Cork Gasket (Do Not Use Perfect Seal)
g - Thermostat
h - Housing
i - Plugs
j - Gasket (Coat with Perfect Seal)

305/350 CID Engines



14932

a - Bolts (Torque to Specifications)
b - Lockwashers
c - Cover
d - Gasket (Coat with Perfect Seal)
e - Thermostat
f - Cork Gasket (Do Not Use Perfect Seal)
g - Sleeve (Turned-In Edge Up)
h - Housing
i - Gasket with Continuity Rivets (Do Not Use Perfect Seal)

454 CID Engines

⚠CAUTION
Do not operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged.

8. Start engine and inspect for leaks.

Changing Coolant

Coolant Recommendations

⚠CAUTION

Alcohol or Methanol base anti-freeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

It is recommended that the coolant section of Closed Cooling System be filled with a 50/50 mixture of ethylene glycol anti-freeze and water. In areas where the possibility of freezing Does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturers recommendations).

Change Intervals

The old coolant should be drained and flushed from the closed cooling system at least every two (2) years or whenever exhaust gases have entered into the system.

Draining Precautions

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

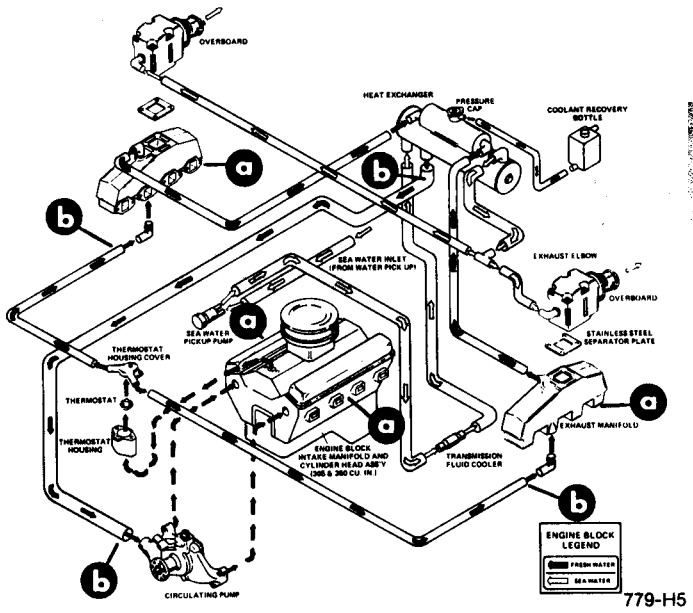
IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On later models with two piece petcocks, removal of petcock may be required so that wire can be inserted completely into drain hole.

NOTE: If possible, place a container under drains to prevent coolant from draining into boat.

MCM/MIE 305/350 CID Models

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

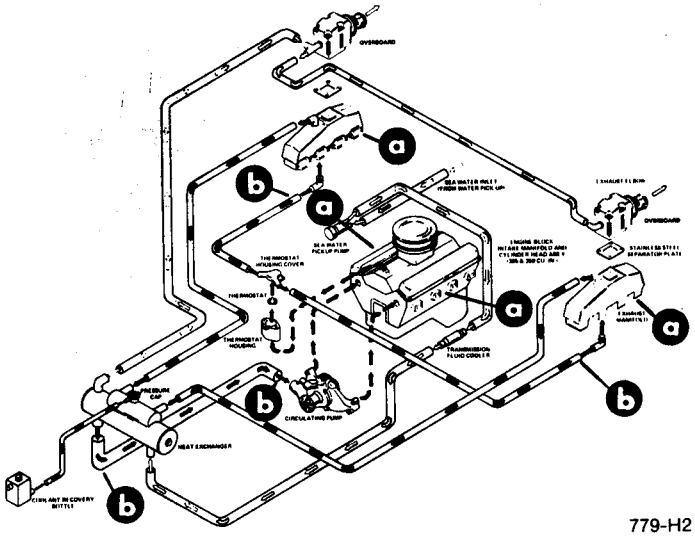
1. Engine must be level to properly drain cooling system.
2. Remove pressure cap from reservoir.
3. Drain coolant as shown.



779-H5

a - Remove Petcock
b - Remove Hose (Lower to Drain)

Rear Mounted Tank



779-H2

a - Remove Petcock
b - Remove Hose (Lower to Drain)

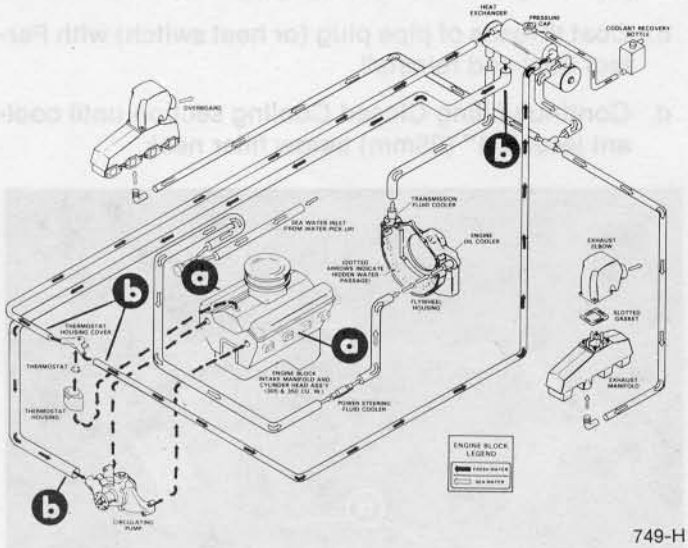
Front Mounted Tank

4. After coolant has drained completely, reinstall petcocks and hoses. Tighten clamps and petcocks securely.
5. Remove coolant recovery bottle from mounting bracket and pour out coolant.
6. Clean system as outlined in "Filling Closed Cooling Section".

MCM 230/260TR

NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Engine must be level to properly drain cooling system.
2. Remove pressure cap from reservoir.
3. Drain coolant as shown.
4. After coolant has drained completely, reinstall petcocks and hoses. Tighten clamps and petcocks securely.
5. Remove coolant recovery bottle from mounting bracket and pour out coolant.
6. Clean system as outlined in "Cleaning System".
7. Fill system as outlined in "Filling Closed Cooling Section".



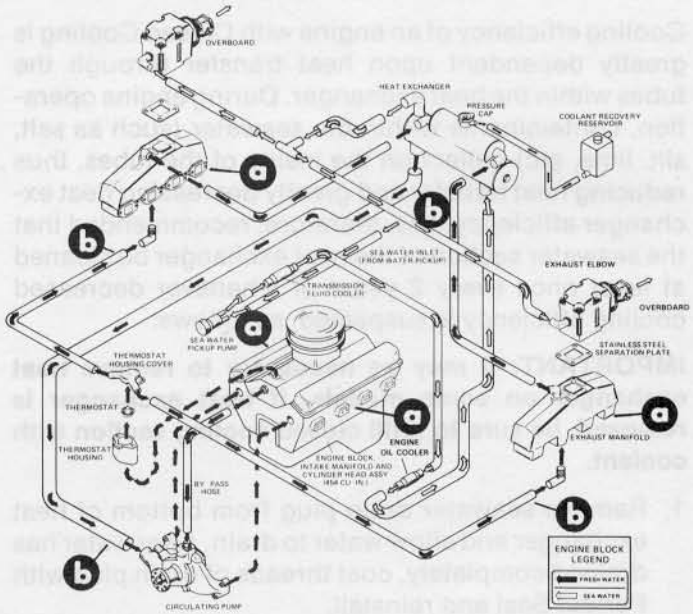
749-H

a - Remove Petcock
b - Remove Hose (Lower to Drain)

MCM/MIE 454 CID Models

NOTICE
Refer to "Draining Precaution", in this section, BEFORE proceeding.

1. Engine must be level to properly drain cooling system.
2. Remove pressure cap.
3. Drain coolant as shown.



a - Remove Petcock
b - Remove Hose (Lower to Drain)

4. After coolant has drained completely, reinstall petcocks and hoses. Tighten clamps and petcocks securely.
5. Remove coolant recovery bottle from mounting bracket and pour out coolant.
6. Clean system as outlined in "Cleaning System".
7. Fill system as outlined in "Filling Closed Cooling Section".

Closed Cooling Section

Closed cooling section of Closed Cooling System should be cleaned at least once every 2 years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale or other foreign material. Manufacturer's instructions, which accompany particular cleaner, always should be followed.

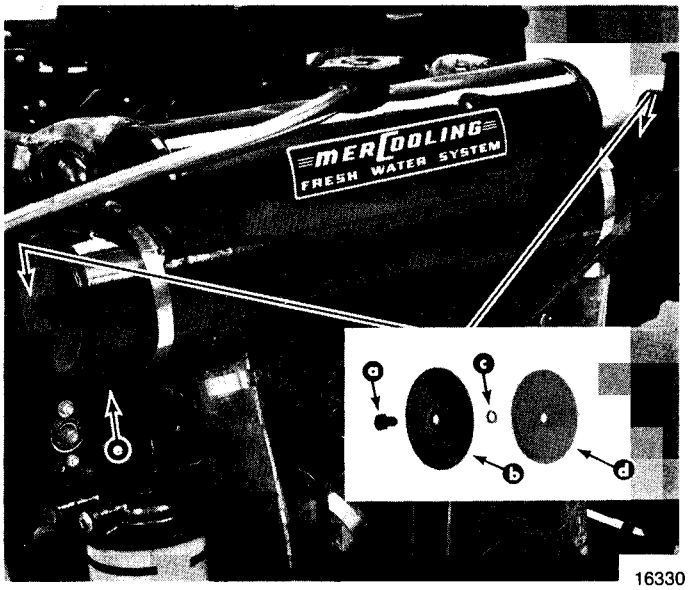
If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions which accompany flushing device for proper hookup and flushing procedure.

Seawater Section

Cooling efficiency of an engine with Closed Cooling is greatly dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, lime, etc) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is, therefore, recommended that the seawater section of the heat exchanger be cleaned at least once every 2 years or whenever decreased cooling efficiency is suspected, as follows:

IMPORTANT: It may be necessary to remove heat exchanger on some models. If heat exchanger is removed, be sure to refill closed cooling section with coolant.

1. Remove seawater drain plug from bottom of heat exchanger and allow water to drain. After water has drained completely, coat threads of drain plug with Perfect Seal and reinstall.



16330

a - Bolt
b - End Cap
c - Sealing Washer
d - Gasket
e - Drain Plug (Refer to "Out-of-Season Storage" for Location on Model Being Worked On)

Typical V-8 Engine

2. Remove bolts, which secure end plates to each end of heat exchanger, then remove end plates, seal washers and gaskets. Discard seal washers and gaskets. Clean gasket material from end plates and heat exchanger.
3. Clean water passages in heat exchanger by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.
4. Apply Perfect Seal to both sides of new end plate gaskets, then reinstall end plates, using new gaskets and seal washers. (Be sure to install seal washers between end plates and gaskets.) Torque end plate bolts to specifications.
5. Start engine and inspect cooling system for leaks.

Filling Closed Cooling Section

NOTICE
See "Specifications" for appoximate closed cooling system capacity and coolant recommendation.

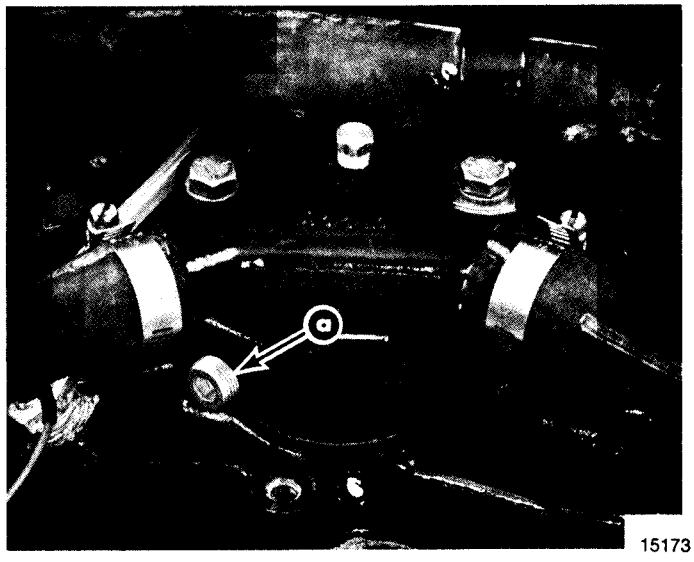
1. Fill closed cooling section with coolant as follows:

Front Mounted Tank

a. Thru heat exchanger filler neck until coolant solution is 1" (25mm) below filler neck.

Rear Mounted Tank

a. Remove pipe plug (or heat switch) from thermostat housing.
b. Fill Closed Cooling section with coolant solution thru heat exchanger filler neck until coolant appears at hole in thermostat housing from which pipe plug (or heat switch) was removed.
c. Coat threads of pipe plug (or heat switch) with Perfect Seal and reinstall.
d. Continue filling Closed Cooling section until coolant level is 1" (25mm) below filler neck.



15173

a - Pipe Plug (or Heat Switch)

V-8 Thermostat Housing

⚠CAUTION

- **DO NOT operate engine without water flowing thru seawater pickup pumps, as pump impeller may be damaged and subsequent overheating damage to engine or stern drive unit may result.**
- **Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the possibility of air being trapped in the closed cooling section which can cause engine to overheat.**
- **Models with belt drive seawater pickup pump must be in the water when running engine because garden hose will not supply enough water to system at higher RPM.**

2. With pressure cap off, start engine and run at fast idle (1500-1800 RPM). Add coolant solution to heat exchanger, as required, to maintain coolant level 1" below filler neck.
3. After engine has reached normal operating temperature (themostat is fully open), and coolant level remains constant, fill heat exchanger to bottom of filler neck.
4. Observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.
5. Install pressure cap on heat exchanger.
6. Remove cap from coolant recovery reservoir and fill to "Full" mark wiht coolant solution. Reinstall cap.
7. With engine still running, check hose connections, fittings and gaskets for leaks. Repeat step 4.

IMPORTANT: Engine overheating is often due to air being trapped in fresh water section. Purge air by running engine at 2000 RPM for 10 minutes.

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

8. Recheck coolant level after first open-throttle boat test and add coolant, if necessary.
9. Maintain coolant level in coolant recovery reservoir between "Add" and "Full" marks with engine at normal operating temperature.

Out-of-Season Storage

Closed Cooling Section

Closed cooling section of Closed Cooling System should be kept filled year around with recommended coolant solution. Do not drain closed cooling section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that closed cooling section is filled with an ethylene glycol anti-freeze and water solution, mixed to manufacturer's recommended proportion, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant.

Seawater Section Draining Precautions

⚠CAUTION

If the possibility of freezing exists, seawater section must be drained to prevent freeze damage to cooling system and engine. Seawater section also should be drained if boat is to be stored for an extended period of time, to prevent corrosion damage.

⚠CAUTION

If boat is in the water, water inlet valve (if so equipped) must be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a valve, water inlet hose must be left disconnected and plugged to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve must be opened or the water inlet hose reconnected prior to starting the engine.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes.

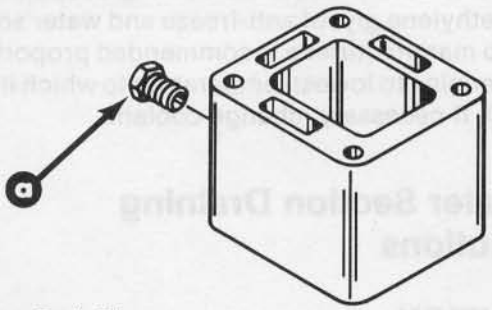
IMPORTANT: To prevent threads in elbows from rusting out during storage, reinstall plugs using Perfect Seal on threads. Never leave drain plugs out during storage.

NOTE: If possible, place a container under drains to prevent water from draining into boat.

MCM/MIE 305/350 CID Models

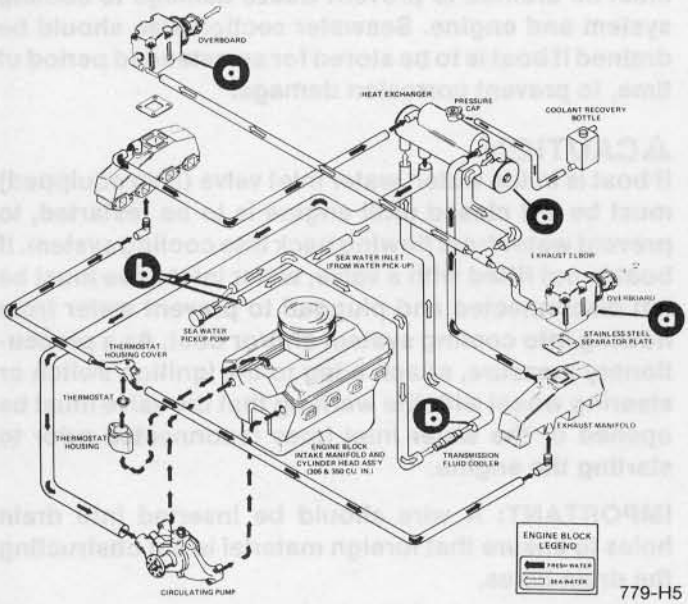
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Drain system as shown. Engine must be level to properly drain cooling system.



a - Remove Drain Plug

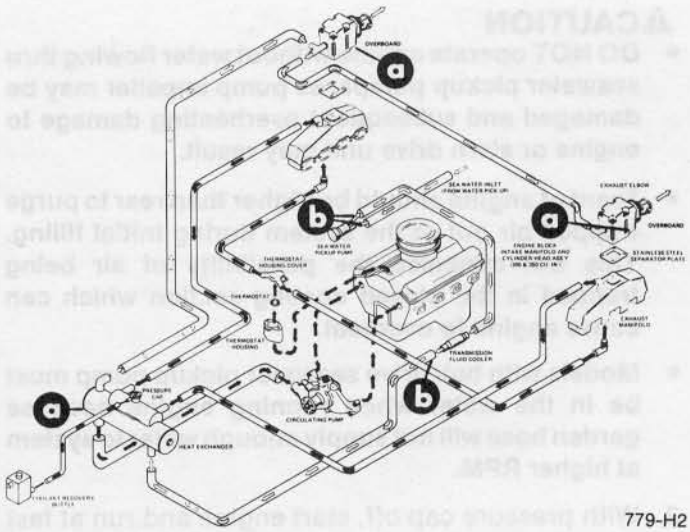
3" or 6" Risers (If Equipped)



779-H5

a - Remove Drain Plug
b - Remove Hose (Lower to Drain)

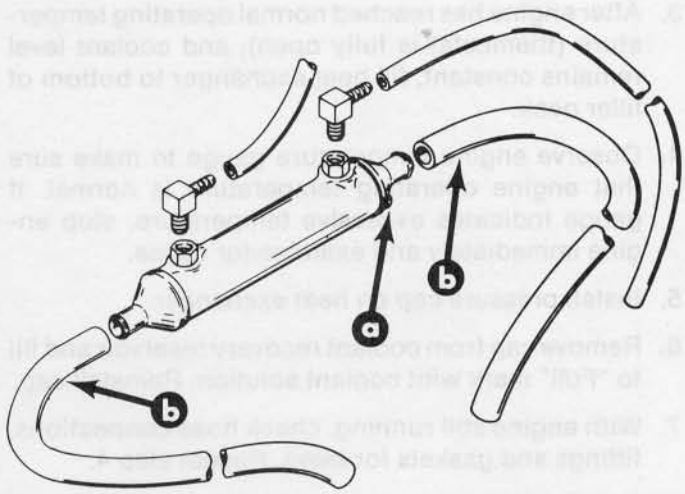
Rear Mounted Tank



779-H2

a - Remove Drain Plugs
b - Remove Hose (Lower to Drain)

Front Mounted Tank



a - Remove Drain Plug
b - Cooler Without Drain Plug - Remove Hoses, Lower to Drain

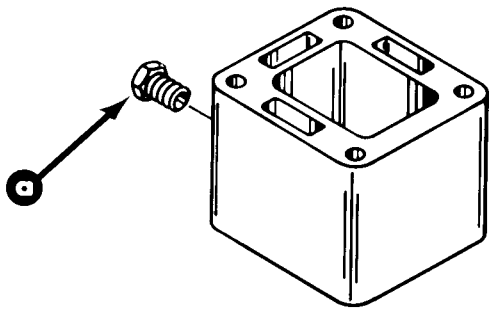
Power Steering Fluid Cooler (If Equipped)

2. Crank engine over slightly, with starter motor, to purge any water trapped in seawater pickup pump. Do not allow engine to start.
3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect hoses. Be sure to tighten hose clamps and drain plugs securely.

MCM/MIE 454 CID Models

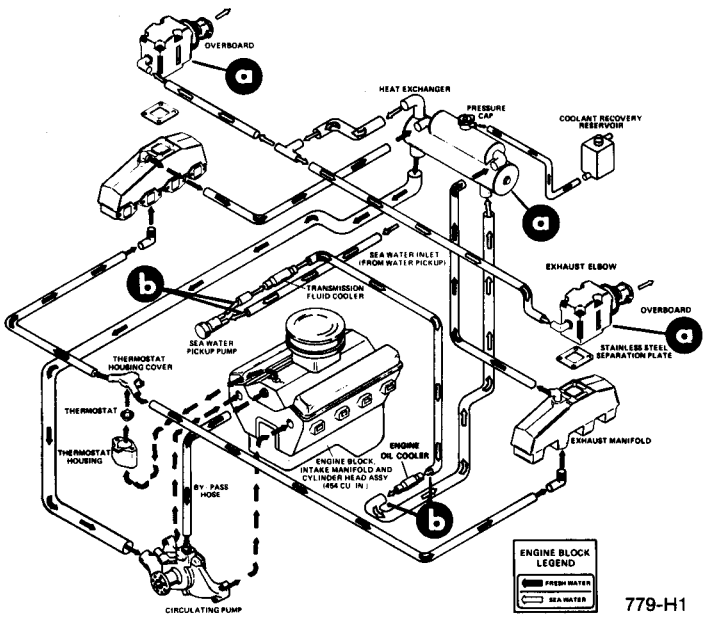
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Drain system as shown. Engine must be level to properly drain cooling system.

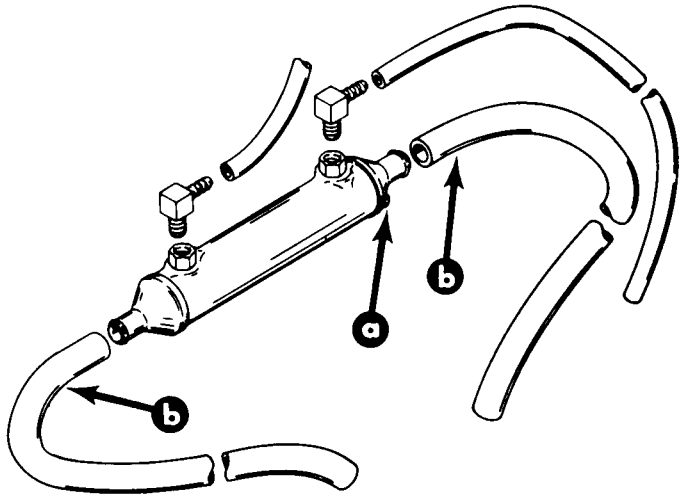


a - Remove Drain Plug

3" or 6" Risers (If Equipped)



a - Remove Drain Plug
b - Remove Hose (Lower to Drain)



a - Remove Drain Plug
b - Cooler Without Drain Plug - Remove Hoses, Lower to Drain

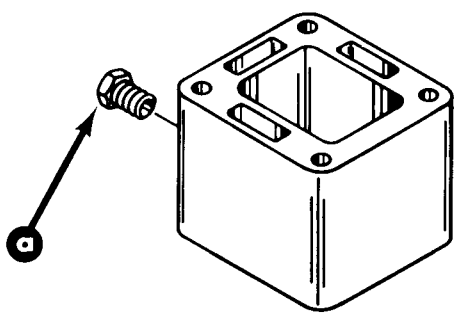
Power Steering Fluid Cooler (If Equipped)

2. Crank engine over slightly, with starter motor, to purge any water trapped in seawater pickup pump. Do not allow engine to start.
3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect hoses. Be sure to tighten hose clamps and drain plugs securely.

MCM 230/260TR

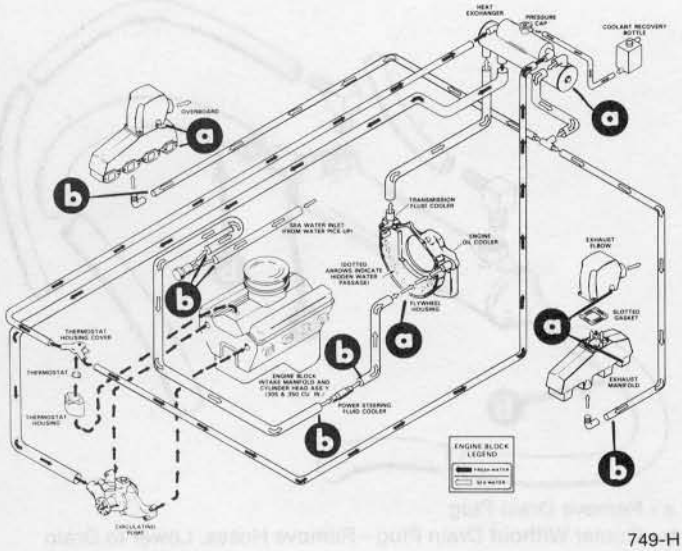
NOTICE
Refer to "Draining Precautions", in this section, BEFORE proceeding.

1. Drain system as shown. Engine must be level to properly drain cooling system.



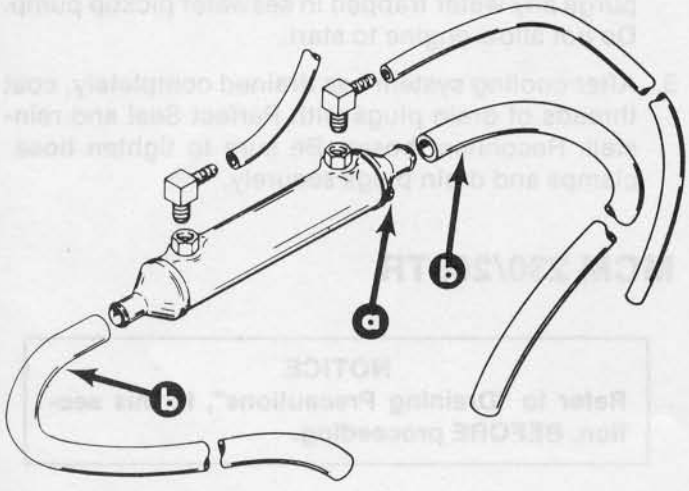
a - Remove Drain Plug

3" or 6" Risers (If Equipped)



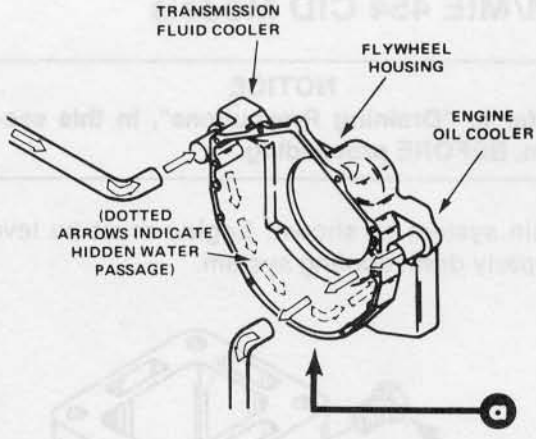
749-H

a - Remove Drain Plugs
b - Remove Hose (Lower to Drain)



a - Remove Drain Plug
b - Cooler Without Drain Plug - Remove Hoses, Lower to Drain

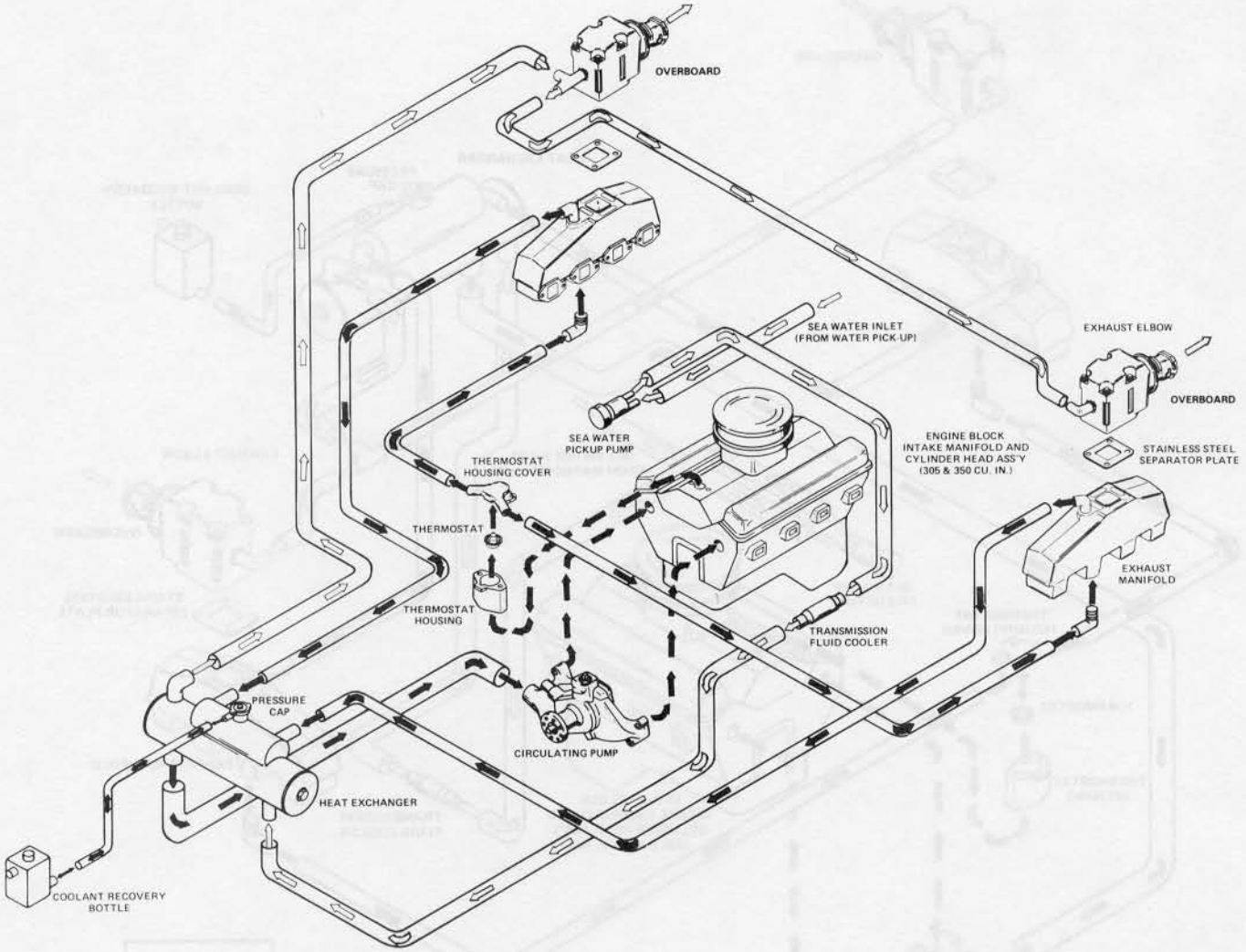
Power Steering Fluid Cooler (If Equipped)

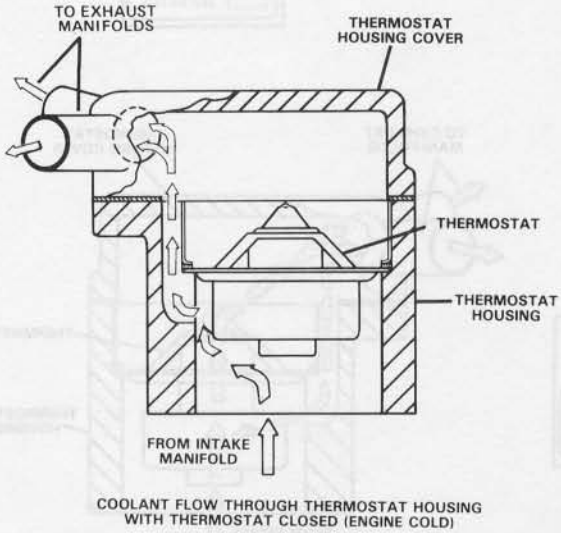


a - Drain Plug on Bottom of Flywheel Housing - Drains Both Coolers

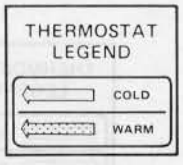
Dual Cooler Flywheel Housing

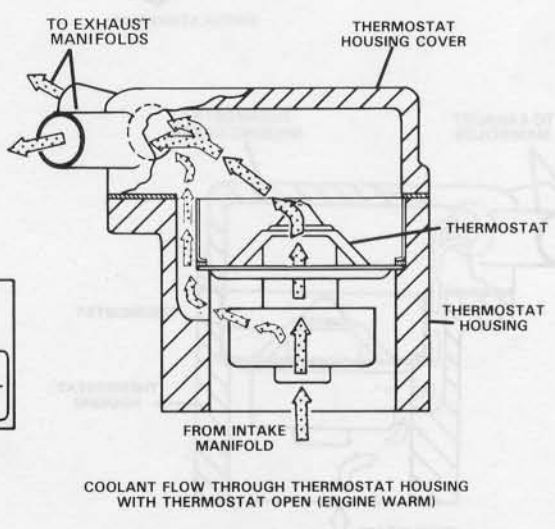
2. Crank engine over slightly, with starter motor, to purge any water trapped in seawater pickup pump. Do not allow engine to start.
3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect hoses. Be sure to tighten hose clamps and drain plugs securely.





COOLANT FLOW THROUGH THERMOSTAT HOUSING
WITH THERMOSTAT CLOSED (ENGINE COLD)

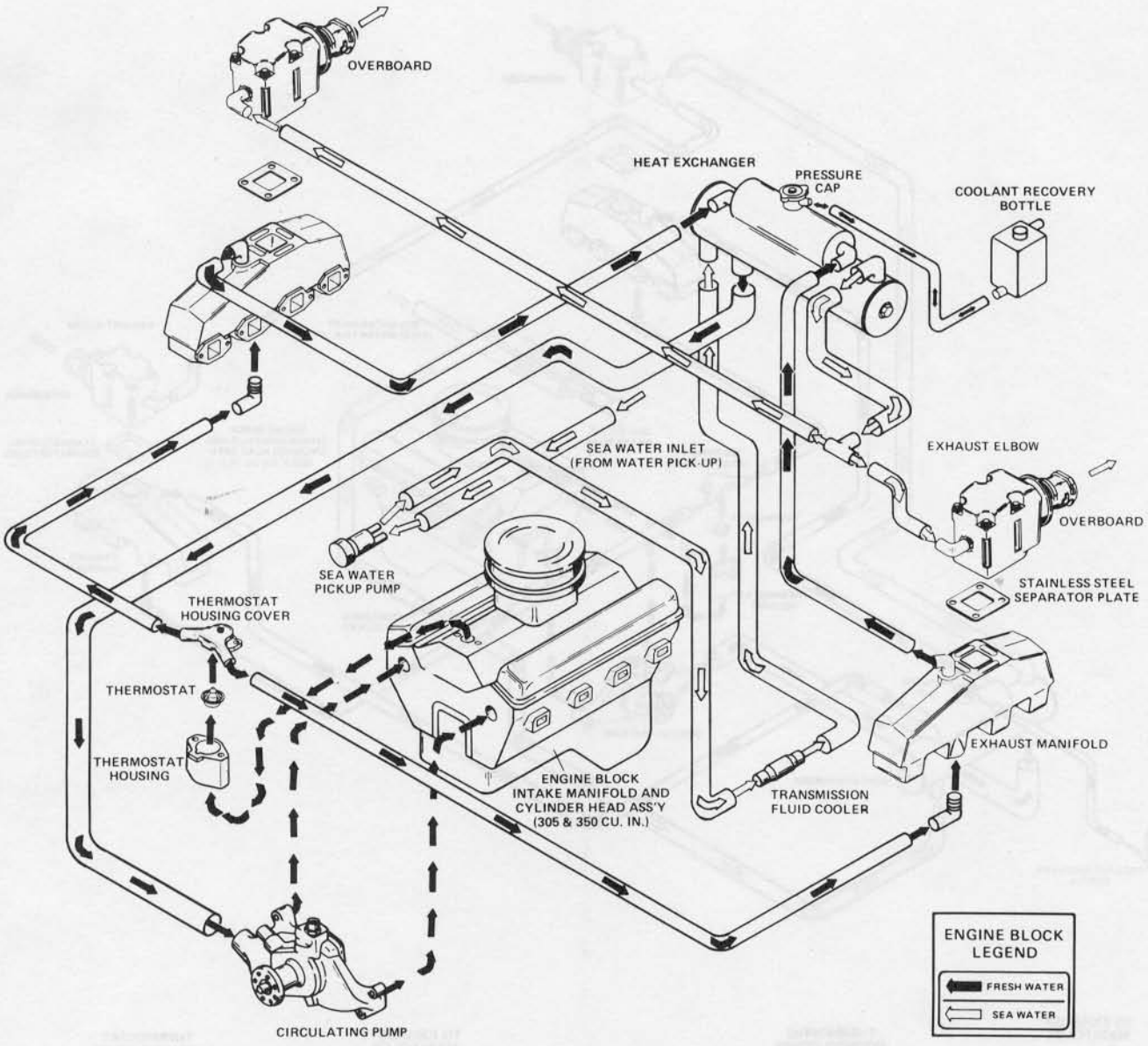


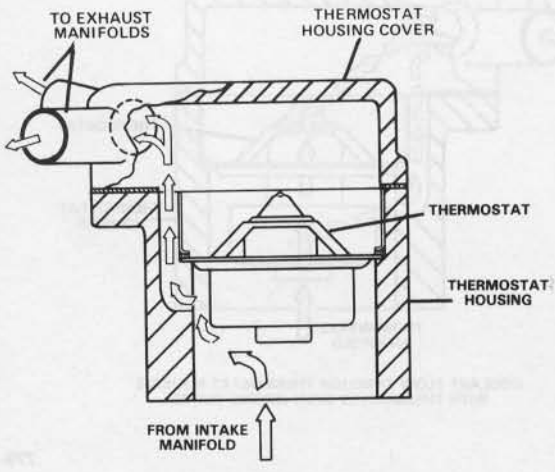


COOLANT FLOW THROUGH THERMOSTAT HOUSING
WITH THERMOSTAT OPEN (ENGINE WARM)

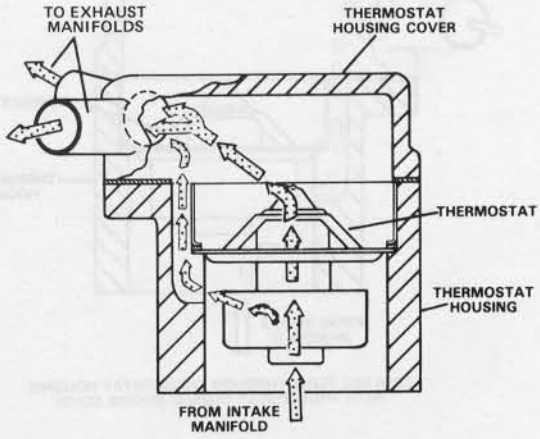
779-H2

**MCM 200/230/260/5.0 Litre/5.0 Litre LX/5.7 Litre -
MIE 230/260 Front Mounted Tank**





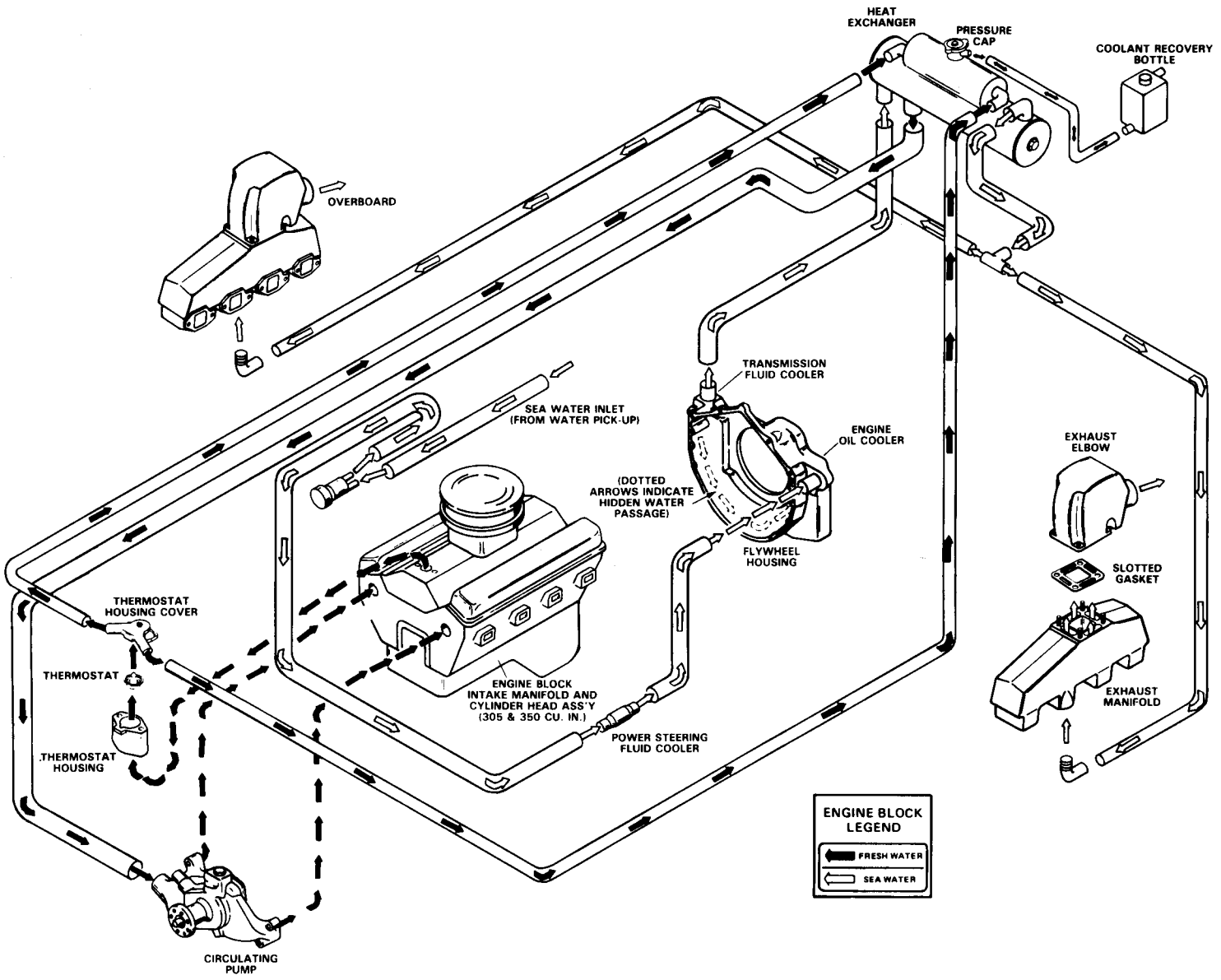
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)

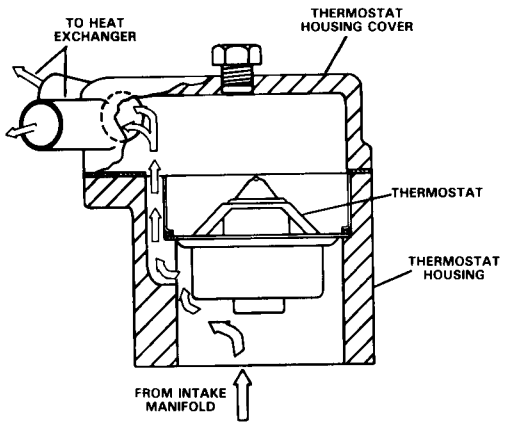


COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN (ENGINE WARM)

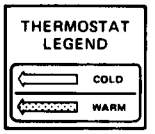
779-H5

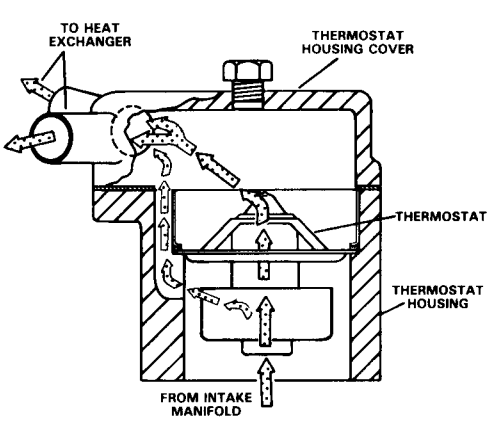
MCM 200/230/260/5.0 Litre/5.0 Litre LX/5.7 Litre - MIE 230/260 Rear Mounted Tank





COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)

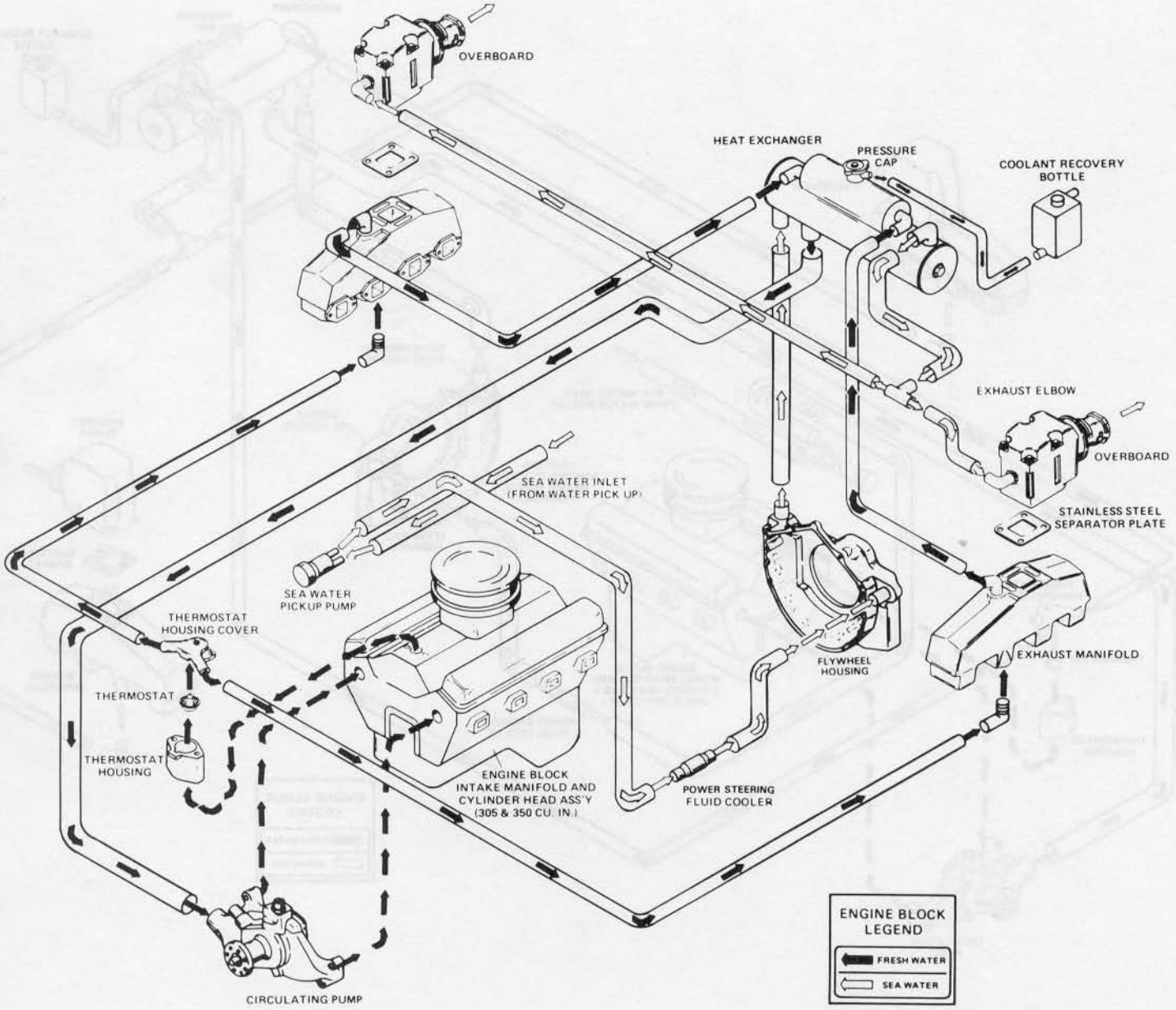


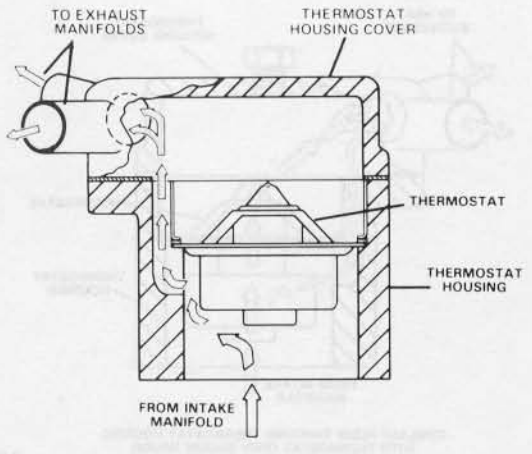


COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN (ENGINE WARM)

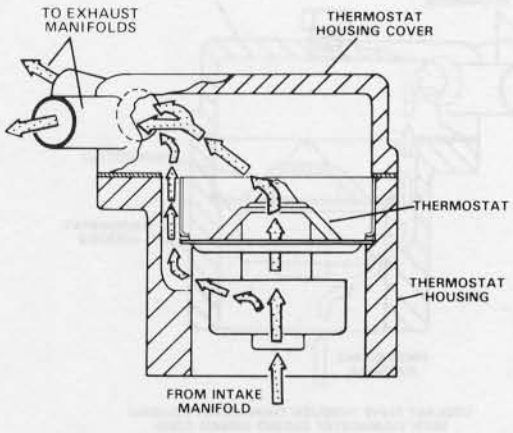
749-H

MCM 230/260TR (Early)





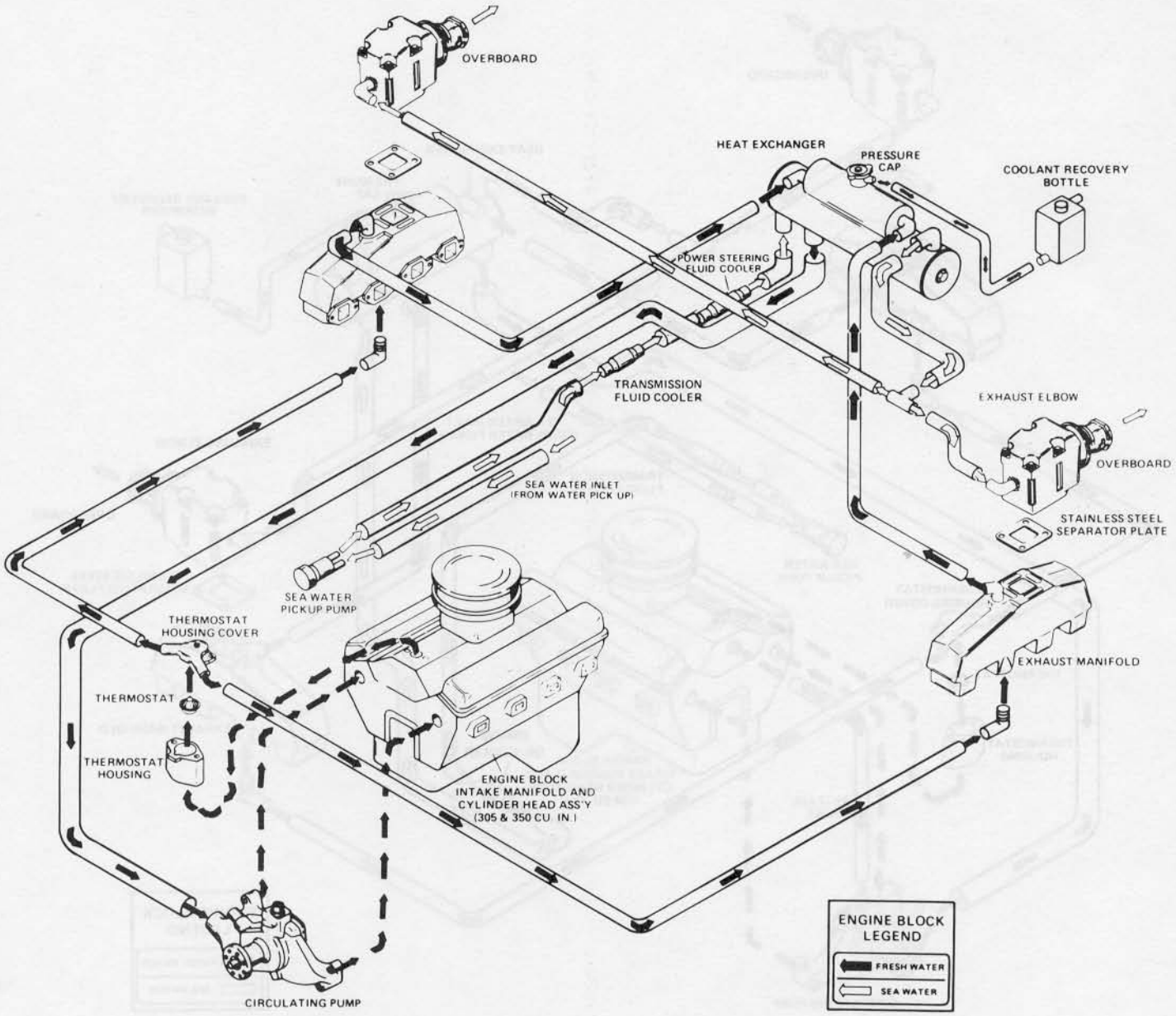
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)

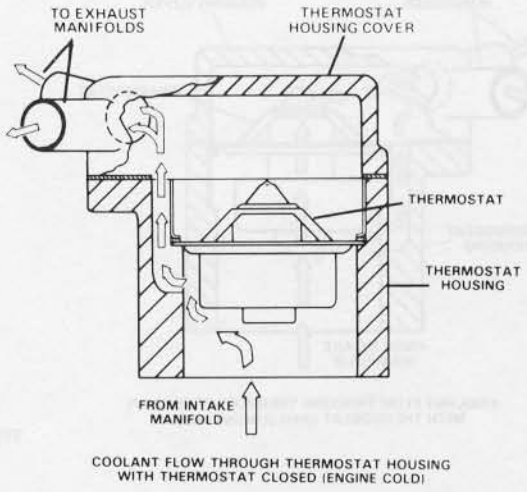


COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN (ENGINE WARM)

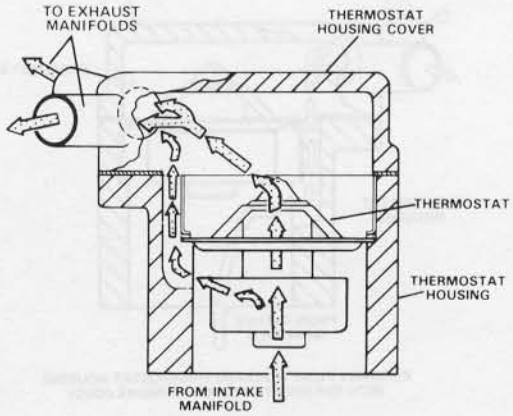
779-H8

MCM 230/260/5.7 Litre





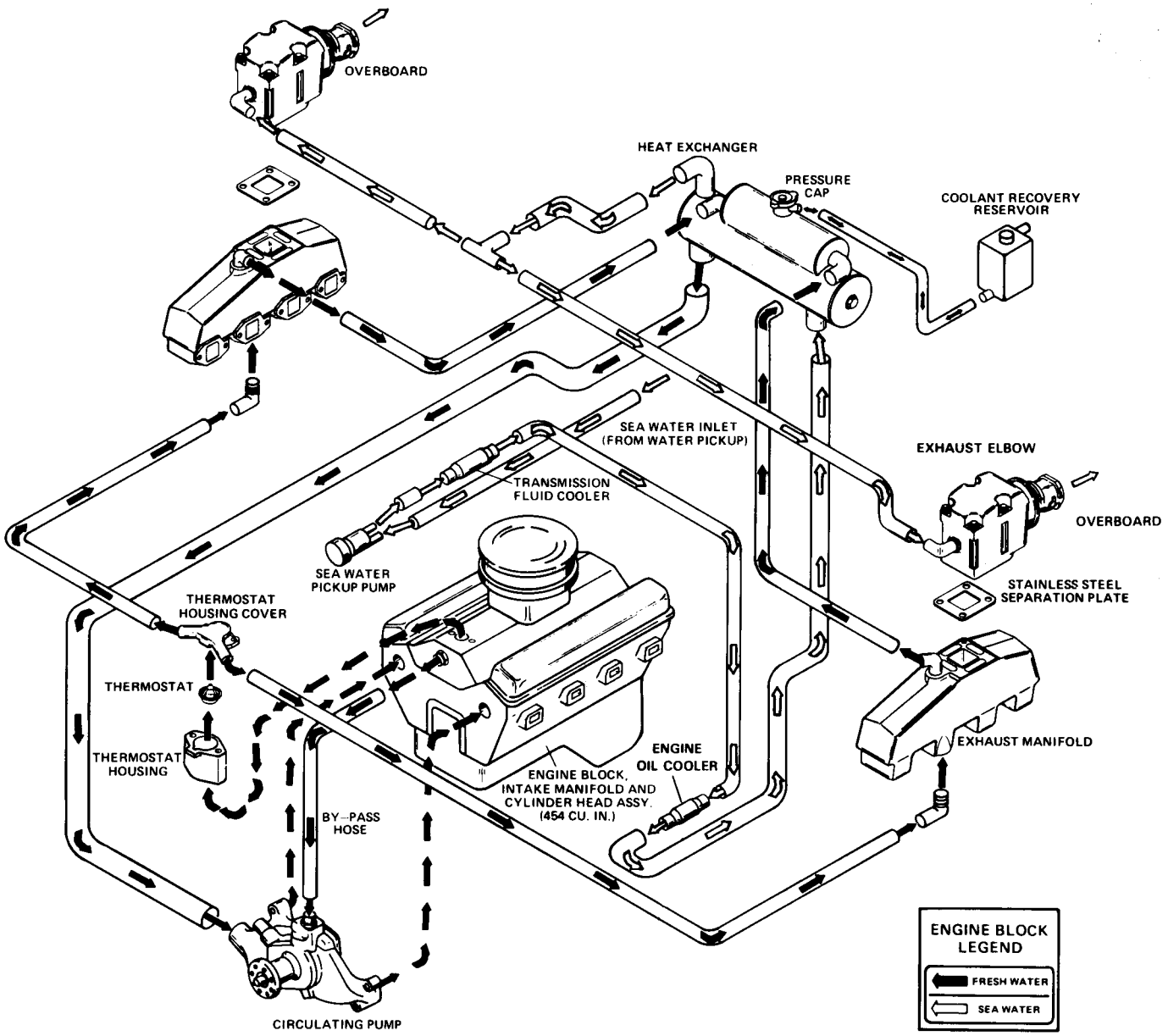
COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)

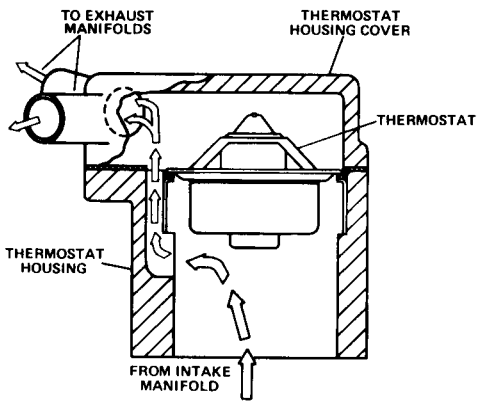


COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN (ENGINE WARM)

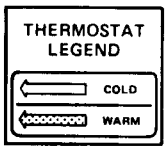
779-H9

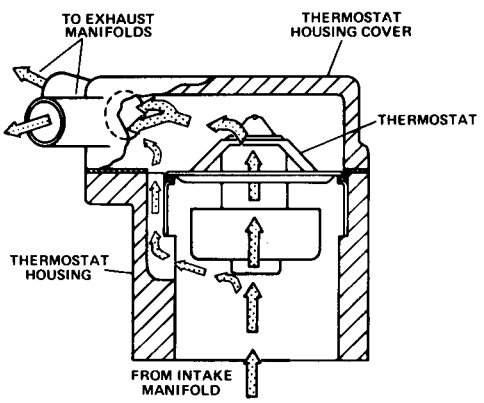
MCM 230 (Serial No. B517365 Up)/
MCM 260TR (Serial No. B517385 Up)
5.0 Litre/5.7 Litre





COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)



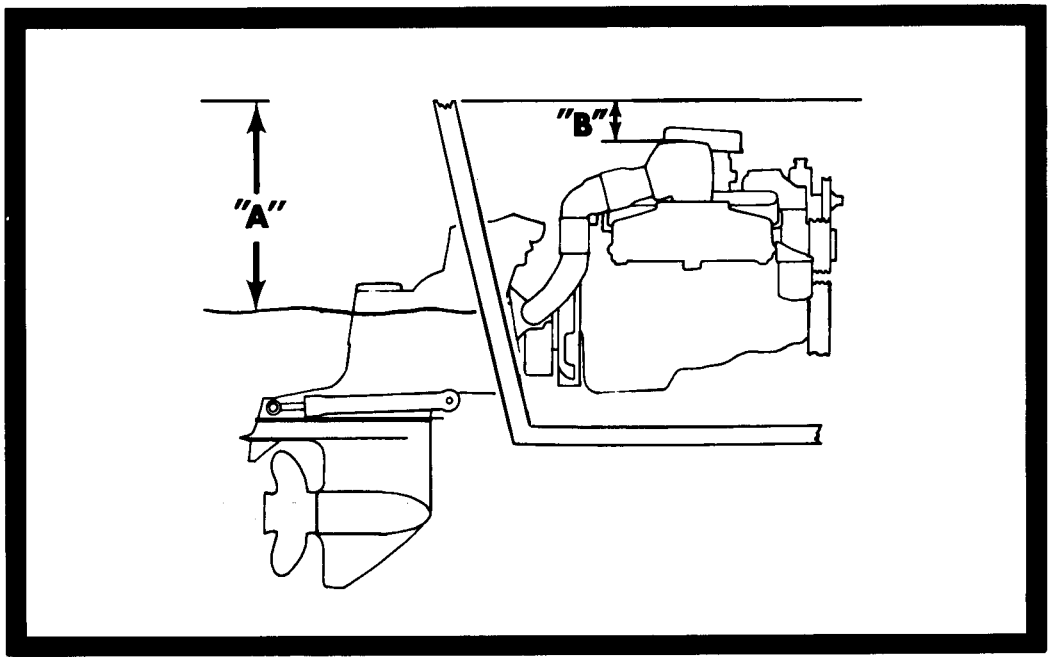


COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN (ENGINE WARM)

779-H1

MCM 330 B-W/MIE 340/7.4 Litre

EXHAUST SYSTEM



GENERAL INFORMATION

A 7

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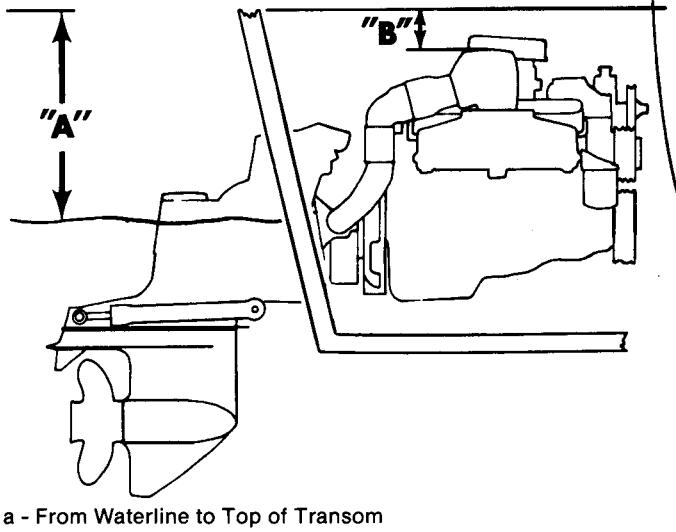
Exhaust System Requirements	7A-1
MCM Engines with Thru Drive Unit Exhaust	7A-1
MCM Engines with Thru Transom Exhaust	7A-1
MCM 200, 230, 260, 330 B/W Engines with Thru Transom Exhaust Conversion	7A-2
MIE Inboard Engines	7A-3

Exhaust System Requirements

MCM Engines With Thru Drive Unit Exhaust

⚠CAUTION
It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective part(s).

Determine if exhaust elbow risers are required by taking measurements "A" and "B", shown following, with boat at rest in the water and maximum load aboard. Subtract "B" from "A". If "A" minus "B" is less than 13 in. (33cm), select appropriate size exhaust elbow riser kit and exhaust extension kit that will correctly position exhaust elbow. See the "Quicksilver Accessory Guide" for part numbers and ordering information.



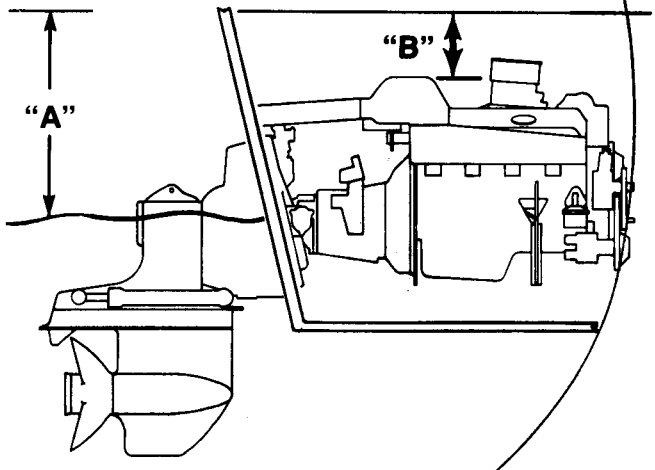
a - From Waterline to Top of Transom
b - From Highest Point on Exhaust Elbow to Top of Transom

Exhaust Elbow Measurement

MCM Engines With Thru Transom Exhaust

⚠CAUTION
It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective parts(s).

Determine if exhaust elbow risers are required by taking measurements "A" and "B", shown following, with boat at rest in the water and maximum load aboard. Subtract "B" from "A". If "A" minus "B" is less than 15 in. (38.1cm), select appropriate size exhaust elbow riser kit that will correctly position exhaust elbows. Also, a 1/2 in. (13mm) per foot (30.5cm) downward drop must exist in the exhaust hose from the engine exhaust elbow to the transom outlet.



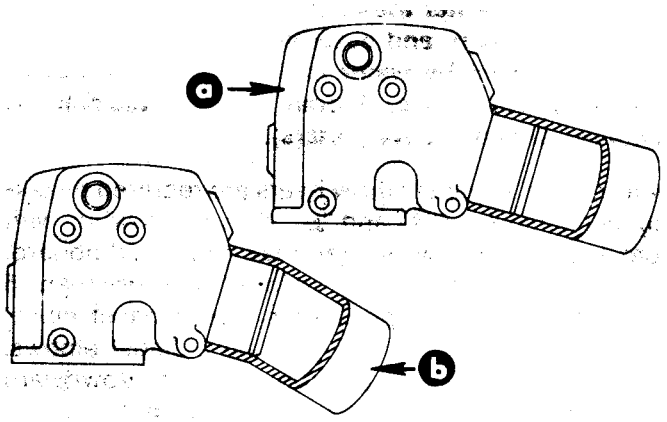
a - From Waterline to Top of Transom
b - From Highest Point on Exhaust Elbow to Top of Transom

Exhaust Elbow Measurement

Wrong

Exhaust hoses must not restrict discharge water flow at exhaust elbow. Transom outlet should have internal water shutters and outlet covers ("flappers") on outside.

IMPORTANT: For MCM 200, 230, 260, 330 B/W engines, also refer to "MCM 200, 230 260, 330 B/W Engines", following.



a - Correct
b - Incorrect
Hose Connection

Engines with Thru Transom Exhaust Conversion

There are no kits to convert these engines from thru drive to thru transom exhaust. By using block off plates, inboard exhaust elbows, exhaust hoses and transom outlet fitings, many engines have been converted to thru transom exhaust. In addition to the preceding information, the following should be adhered to:

- "Exhaust Elbow Measurement" must be checked See "MCM Engines with Thru Drive Unit Exhaust".
- Block off plates (for drive exhaust system) must be able to prevent water from entering the boat.
- Exhaust bellows (between gimbal housing and bell housing) should be removed to allow propeller to draw air.

MCM 200, MCM 230, MCM 260, 5.0 Litre, 5.0 Litre LX, 5.7 Litre ENGINES ONLY

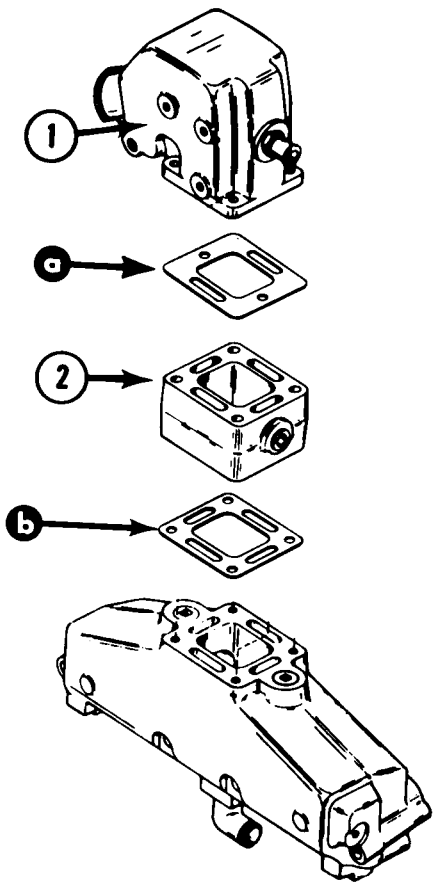
1. Exhaust Elbow (without stainless steel tube): MUST BE CHANGED. Order:

   (2) 98504A3 Exhaust Elbows
   (2) 27-41813 Exhaust Elbow Restrictor Gaskets

NOTE: If engine has stainless steel restrictor plate (99208A1), discard plate when using 27-41813 Restrictor Gaskets.

2. 3 in. or 6 in. Exhaust Elbow Riser Kits: If these kits are going to be used, restrictor gasket (a) MUST BE INSTALLED between the riser and exhaust elbow.

   27-87105 gasket (b) is installed at location shown.



MCM 200/230/260 Only

⚠CAUTION

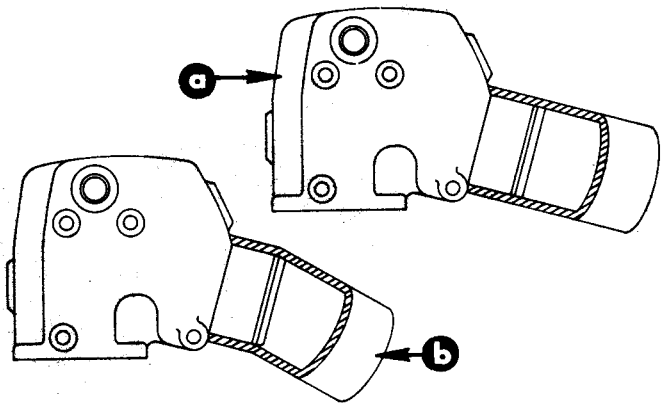
It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective part(s).

1. System layout and construction must prevent cooling system discharge water from flowing back into engine and also must prevent seawater from entering engine via exhaust system. All cooling system water is discharged thru openings which are located inside the exhaust elbows. To prevent discharge water from flowing back into the engine, the exhaust hoses and pipes must not be higher than exhaust elbows at any point. The exhaust outlet (for routing exhaust to outside of boat) must be located so that a minimum of 1/2 in. (13mm) per foot (30.5cm) downward pitch (drop) exists in the exhaust hose or pipe from the engine exhaust elbow to the outlet, with a minimum drop of 4 in. (10cm) overall. (This is an American Boat & Yacht Council recommendation.) The drop must be constant so that a low spot does not exist at any point in the exhaust hose or pipe. Exhaust outlet must be slightly above the waterline with boat at rest in the water and full load aboard. Exhaust outlet should be equipped with an internal water shutter to prevent seawater from running back into exhaust system. If thru-transom exhaust outlets are used, use of an exhaust flapper on each outlet also is recommended.
2. Determine if exhaust elbow risers are required by taking measurements "A" and "B", shown following, with boat at rest in the water and maximum load aboard. Subtract "B" from "A". If "A" minus "B" is less than 13 in. (33cm), select appropriate size exhaust elbow riser kit that will correctly position exhaust elbows.
3. System must not cause excessive back pressure. Back pressure MUST NOT exceed 4 in. (100mm) of mercury when measured with a mercury manometer at exhaust elbow outlets. Minimum exhaust hose sizes are given in charts.

305/350 CID MINIMUM EXHAUST HOSE SIZES	
Dual Exhaust	3 in. (76mm)
Single Exhaust	4 in. (102mm)

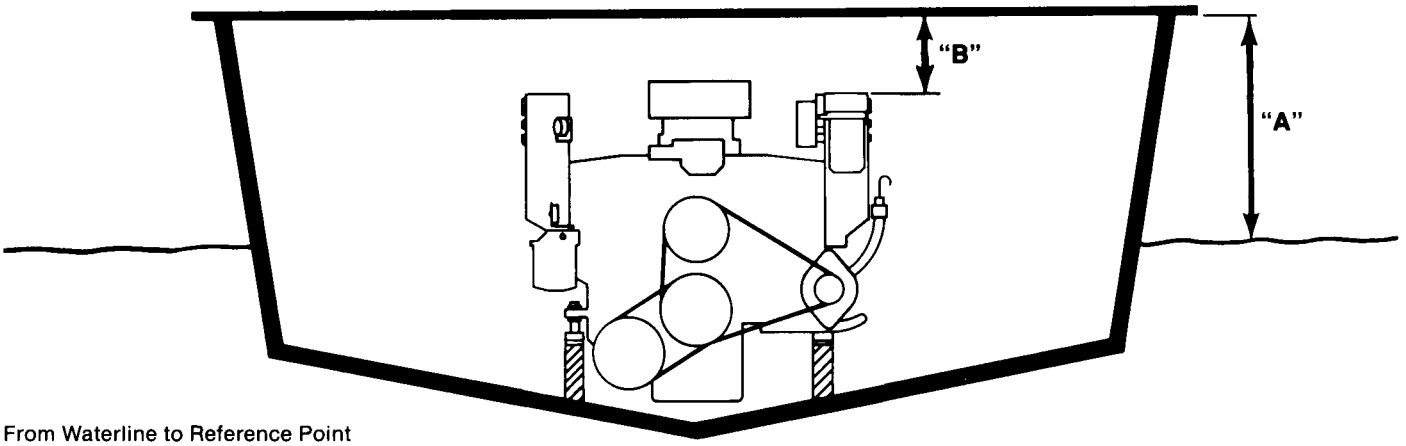
454 CID	
Dual Exhaust	3 in. (76mm)
Single Exhaust	5 in. (127mm)

4. Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from the elbow. If hoses are connected incorrectly, discharge water from exhaust elbow will not flow around entire inside diameter of hose. This will cause a hot spot in the hose which may eventually burn thru.



a - Correct
b - Incorrect

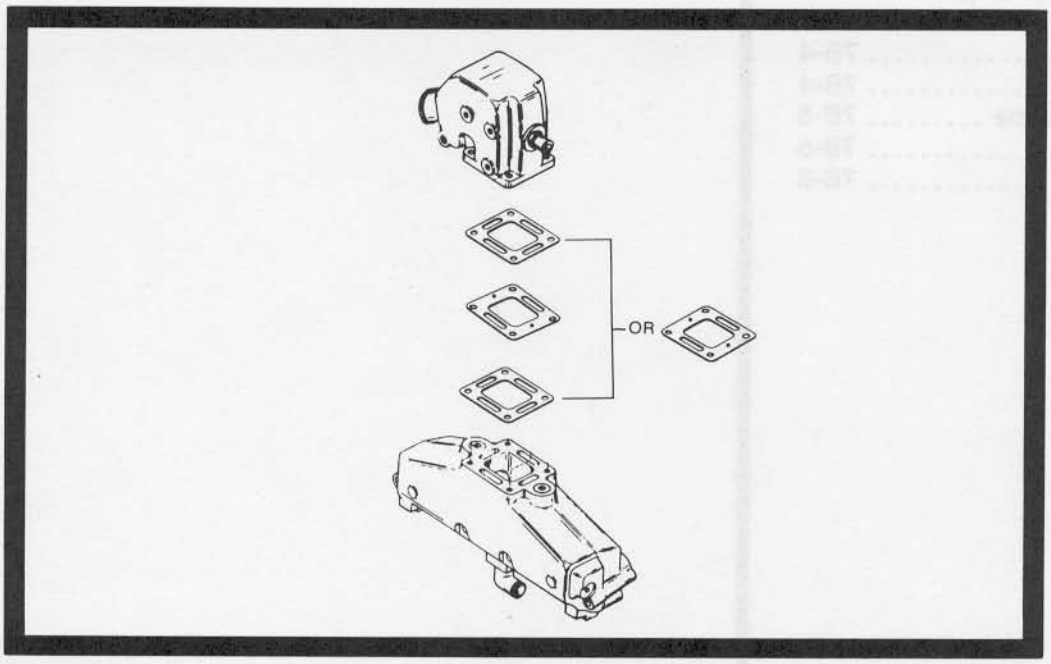
Hose Connection



a - From Waterline to Reference Point
b - From Highest Point on Exhaust Elbow to Same Reference Point

Exhaust Elbow Measurement

EXHAUST SYSTEM



EXHAUST MANIFOLDS/ELBOWS

B 7

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Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Hose Clamps	Securely	
Distribution Block	25 (34)	
End Cap		96 (11)
Exhaust Elbow	25 (34)	
Exhaust Manifold (Note)	25 (34)	

NOTE: MCM 370TRS, 400TRS, 400/440/460 Cyclone: Torque bolts to 35 lbs. ft. (47 N.m). Torque nuts to 25 lbs. ft. (34 N.m).

Quicksilver Sealants

Repair/replacement procedure(s), outlined in this section, require the use of the following Quicksilver sealants:

- Loctite
- Perfect Seal

Refer to the Quicksilver Accessories Guide for ordering information.

Cleaning and Inspection

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches, or water and exhaust leaks may result.
3. Check water passages for foreign material. Passages must be clean for efficient cooling.
4. If more thorough inspection is desired, pipe plugs may be removed from exhaust manifold and exhaust elbow.

IMPORTANT: If plugs are removed, coat threads with Perfect Seal before reinstalling.

5. Check for cracks.
6. To test manifold body for leaks, block off plates, plugs, or short hoses with plugged ends must be used. One block off plate must have a threaded hole for attaching compressed air hose. Use new gaskets when installing block off plate(s). Apply 40 PSI (276 kPa) of air pressure and submerge manifold in water. Air bubbles will indicate a leak.

Models with Alpha One Drive

Removal

1. Disconnect battery cables from battery.
2. Drain water from manifold and exhaust elbow.
3. Disconnect exhaust bellows and cooling hoses.
4. **Starboard Manifold:**
   a. Disconnect both shift cables.
   b. Disconnect instrument harness plug from engine harness. Remove shift plate assembly from exhaust elbow.
   c. Disconnect fuel lines and remove filter assembly.
   d. Remove circuit breaker/slave solenoid and bracket.

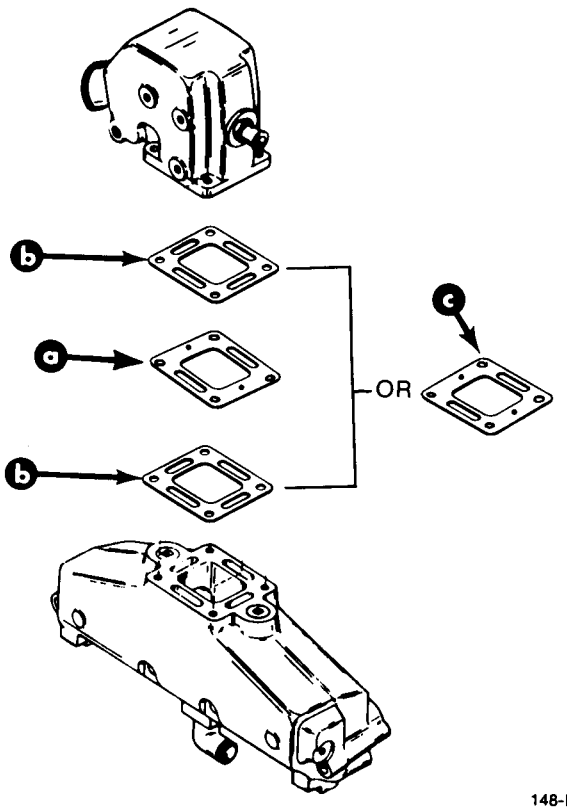
   Port Manifold:
   a. Remove ignition amplifier from exhaust elbow.
   b. Remove remote oil filter and bracket (If equipped).
5. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
6. Remove exhaust elbow.
7. Refer to "Cleaning and Inspection". (See "Index")

Installation

1. Using new gasket, install exhaust manifold to cylinder head. Torque fasteners to 25 lbs. ft. (34 N.m).

IMPORTANT: See Section 7, Part B if exhaust risers are used.

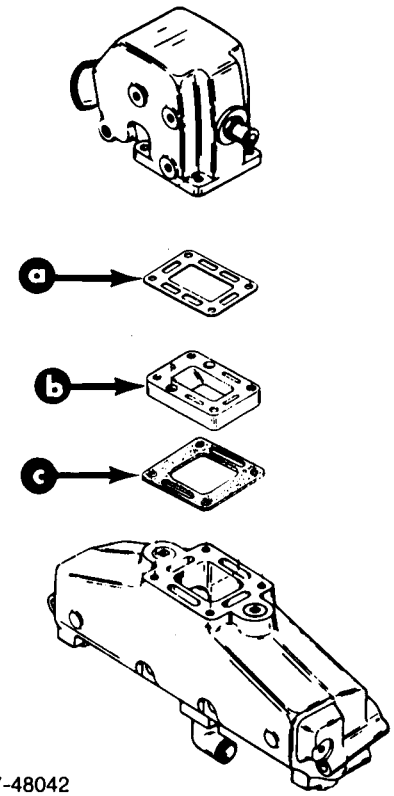
2. Install exhaust elbow. Torque fasteners to 25 lbs. ft. (34 N.m).



148-HR1

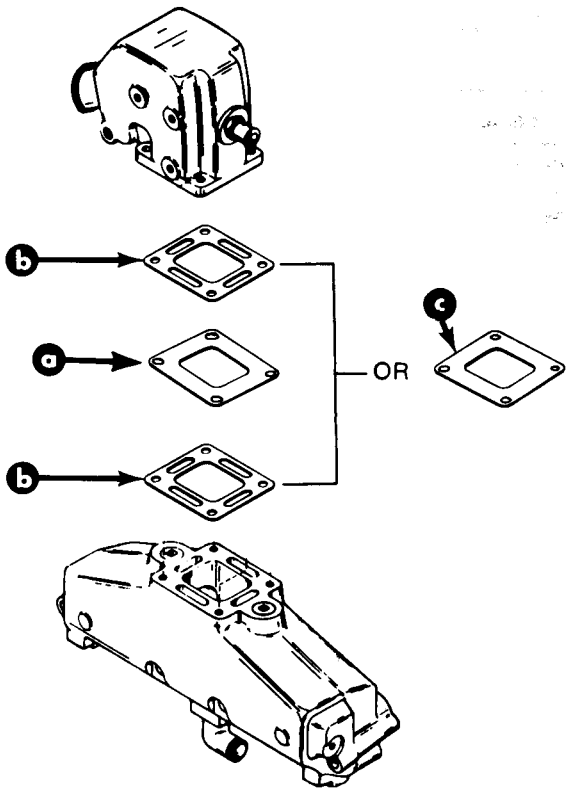
a - Stainless Steel Restrictor Plate
b - Gaskets
c - 27-41813 Restrictor Gasket

Standard Seawater Cooled Models



a - Gasket 27-48042
b - Adaptor
c - Gasket 27-87105

MCM 300 Tempest Alpha One



148-HR2

a - Stainless Steel Separator Plate
b - Gaskets
c - 27-41811 Separator Gasket

Closed Cooling Models

3. **Starboard Manifold:**
   a. Install circuit breaker/slave solenoid and bracket.
   b. Install water separating fuel filter. Reconnect fuel lines. Tighten securely.
   c. Install shift plate assembly. Plug in instrument harness and tighten clamp securely.
   d. Install and adjust shift cables. Refer to appropriate MerCruiser Stern Drive Service Manual.

   Port Manifold:
   a. Install ignition amplifier to exhaust elbow. Tighten bolts securely.
4. Reconnect exhaust bellows and cooling hoses. Tighten clamps securely.
5. Reconnect battery cables to battery. Tighten securely.
6. Start engine and check for fuel, exhaust and water leaks.

Models with Borg-Warner Transmissions

Removal

1. Disconnect battery cables from battery.
2. Drain water from manifold and exhaust elbow.
3. Disconnect exhaust and cooling hoses.
4. **Starboard Manifold:**
   a. Disconnect fuel lines from water separating fuel filter and remove filter assembly.
   b. Disconnect instrument harness plug from engine harness.
   c. Remove circuit breaker/slave solenoid and bracket.

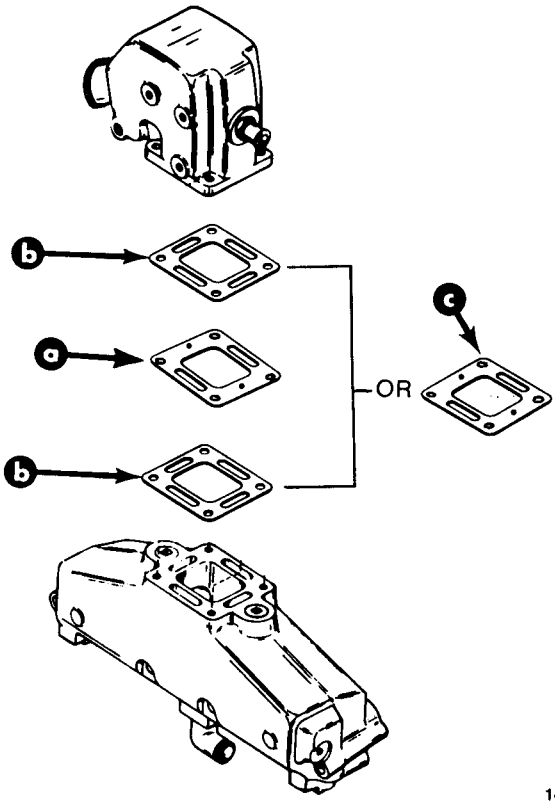
   Port Manifold:

   a. Remove ignition amplifier from exhaust elbow (if equipped).
   b. Remove remote oil filter and bracket.
5. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
6. Remove exhaust elbow.
7. Refer to "Cleaning and Inspection. (See "Index".)

Installation

1. Using new gasket, install exhaust manifold to cylinder head. Torque fasteners to 25 lbs. ft. (34 N.m).
2. **IMPORTANT: See Section 7, Part B if exhaust risers are used.**

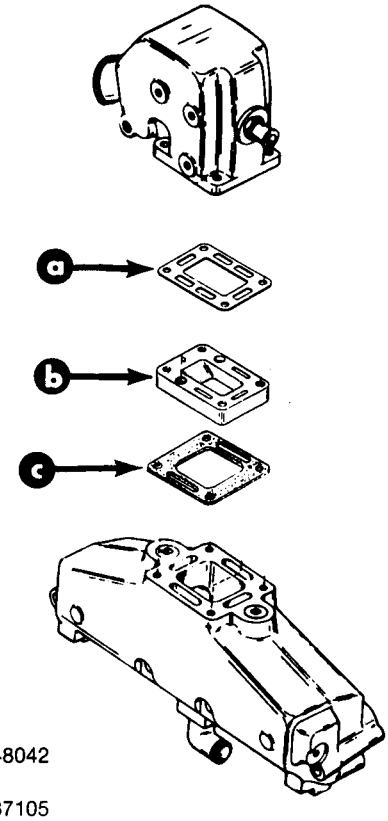
Install exhaust elbow. Torque fasteners to 25 lbs. ft. (34 N.m).



148-HR1

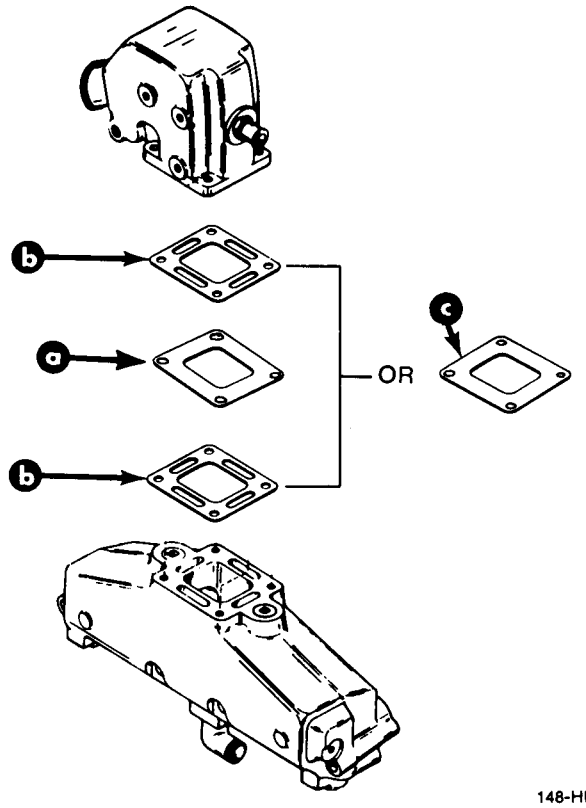
a - Stainless Steel Restrictor Plate
b - Gaskets
c - 27-41813 Restrictor Gasket

Standard Seawater Cooled Models (Except MCM 300 Tempest TRS and MCM 370 [S.N. 6721528 and Above])



a - Gasket 27-48042
b - Adaptor
c - Gasket 27-87105

MCM 300 Tempest TRS and MCM 370TRS (S.N. 6721528 and Above)



148-HR2

a - Stainless Steel Separator Plate
b - Gaskets
c - 27-41811 Separator Gasket

Closed Cooling Models

3. **Starboard Manifold:**
   a. Install circuit breaker/slave solenoid and bracket.
   b. Install water separating fuel filter. Reconnect fuel lines. Tighten securely.
   c. Plug in instrument harness plug and tighten clamp securely.

   Port Manifold:
   a. Install ignition amplifier to exhaust elbow (if equipped). Tighten bolts securely.
   b. Install remote oil filter and bracket. Tighten fasteners securely.
5. Reconnect battery cables to battery. Tighten securely.
6. Start engine and check for fuel, exhaust and water leaks.

MCM 370TRS (S.N. 6721527 and Below), 400TRS, 400 Cyclone

Removal

1. Disconnect battery cables.
2. Drain water from manifold and exhaust elbow.
3. Disconnect exhaust hoses and cooling hoses.
4. **Starboard Manifold:**
   a. Disconnect fuel lines from water separating fuel filter and remove fuel filter assembly.
5. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
6. Remove exhaust elbow.
7. Remove end caps.
8. Refer to "Cleaning and Inspection". (See "Index".)

Installation

1. Install new gaskets and end caps on ends of manifold body. Torque fasteners to 96 lbs. in (11 N.m).
2. **IMPORTANT: See Section 7, Part B if exhaust risers are used.**

Use a new gasket and install exhaust elbow to manifold body. Torque fasteners to 25 lbs. in (34 N.m).

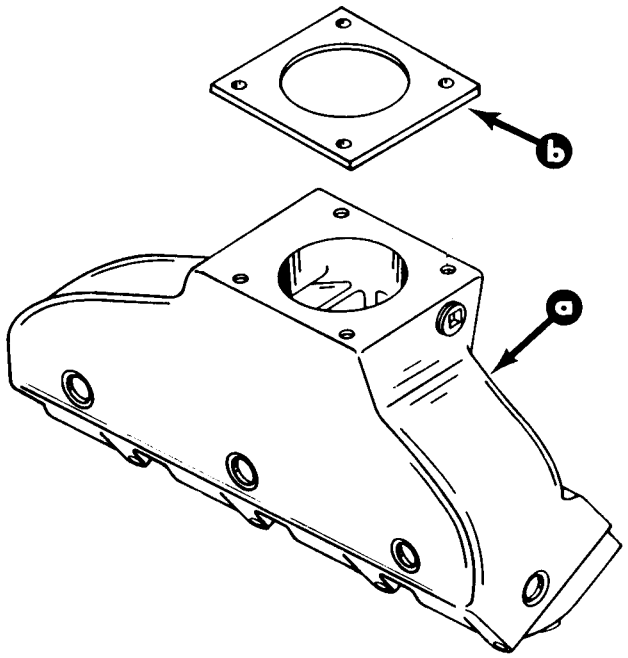
3. Using a new gasket, install manifold. Torque bolts to 35 lbs. ft. (47 N.m). Torque nuts to 25 lbs. ft. (34 N.m)
4. **Starboard Manifold:**
   a. Install water separating fuel filter. Connect fuel lines and tighten securely.
5. Reconnect exhaust and water hoses. Tighten clamps securely.
6. Reconnect battery cables to battery. Tighten securely.
7. Start engine and check for fuel, exhaust and water leaks.

MCM 440/460 Cyclone

440 and 460 cyclones have Gil Marine "header" installed from the factory. From exhaust elbow to outside of vessel is supplied by the boat manufacture.

Removal (Both Sides)

1. Disconnect battery cables.
2. Drain water from manifold and exhaust system.
3. Disconnect exhaust hoses and cooling hoses.
4. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
5. Refer to "Cleaning and Inspection". (See "Index".)



a - Gil Marine Exhaust "Header"
b - Gasket

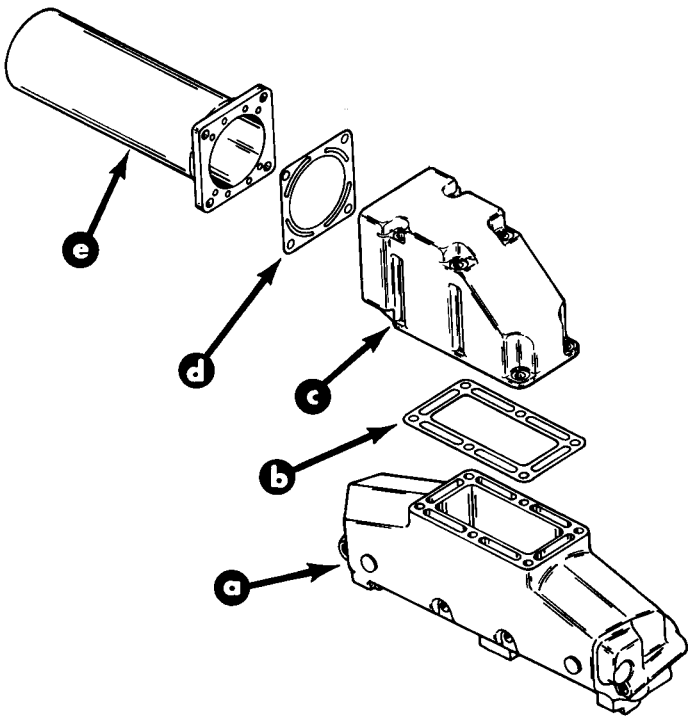
Installation (Both Sides)

1. Using a new gasket, install manifold. Torque bolts to 35 lbs. ft. (47 N.m). Torque nuts to 25 lbs. ft. (34 N.m).
2. Reconnect exhaust and water hoses. Tighten clamps securely.
3. Reconnect battery cables.
4. Start engine and check for fuel, exhaust and water leaks.

MCM 420

Removal (Both Sides)

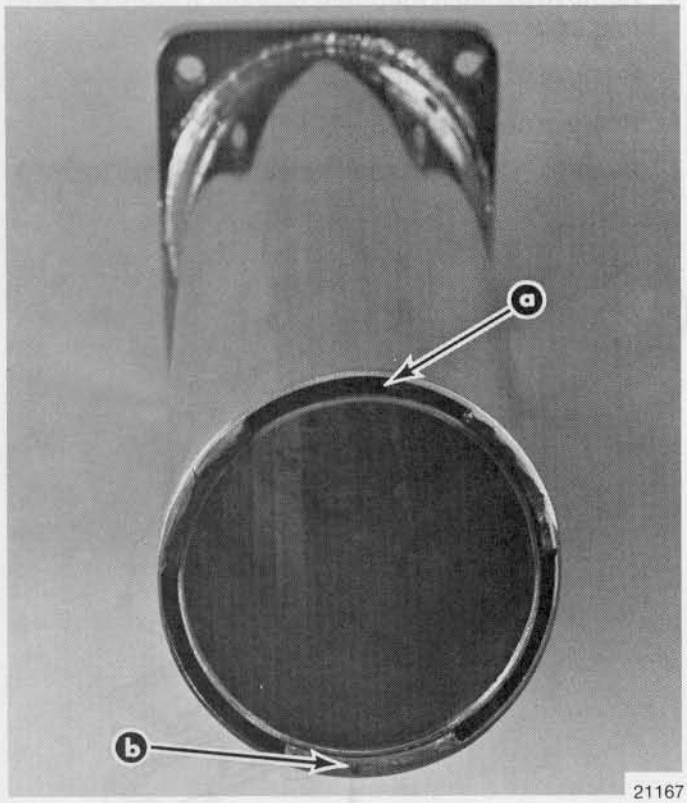
1. Disconnect battery cables.
2. Drain water from manifold and exhaust elbow.
3. Disconnect exhaust hoses and cooling hoses.
4. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
5. Remove exhaust elbow and exhaust pipe.
6. Remove end caps.
7. Refer to "Cleaning and Inspection". (See "Index'.)



a - Exhaust Manifold
b - Gasket
c - Exhaust Elbow
d - Metal Gasket
e - Exhaust Pipe

Installation (Both Sides)

1. Use a new gasket and install exhaust elbow to manifold body. Torque fasteners to 35 lbs. ft. (47 N.m).
2. Using a new gasket, install manifold. Torque bolts to 35 lbs. ft. (47 N.m)
3. Install exhaust pipe with water discharge slot towards the top of exhaust elbow.



a - Water Discharge Slot at 12 O'Clock
b - Weld at 6 O'Clock

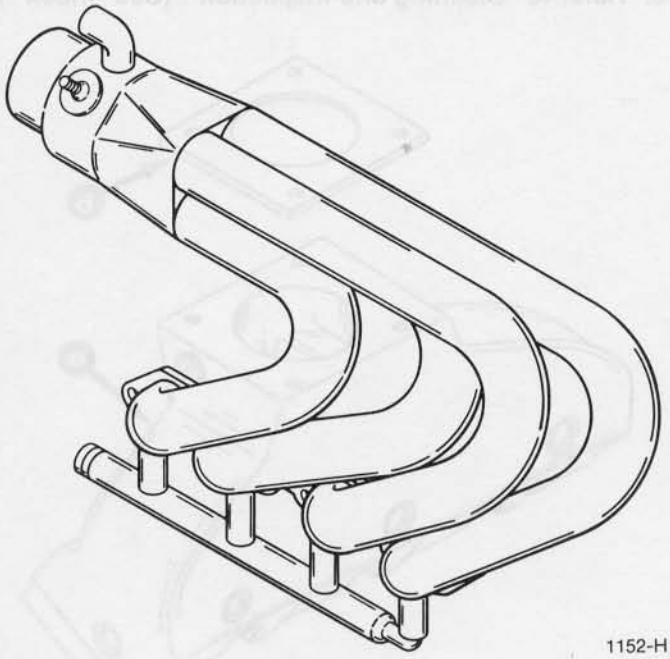
4. Reconnect exhaust and water hoses. Tighten clamps securely.
5. Reconnect battery cables.
6. Start engine and check for fuel, exhaust and water leaks.

MCM 575

MCM 575 models have manufacture installed stelling "headers" made of stainless steel.

Removal

1. Disconnect battery cables.
2. Drain water from manifold.
3. Disconnect exhaust hoses and cooling hoses.
4. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
5. Refer to "Cleaning and Inspection". (See "Index".)

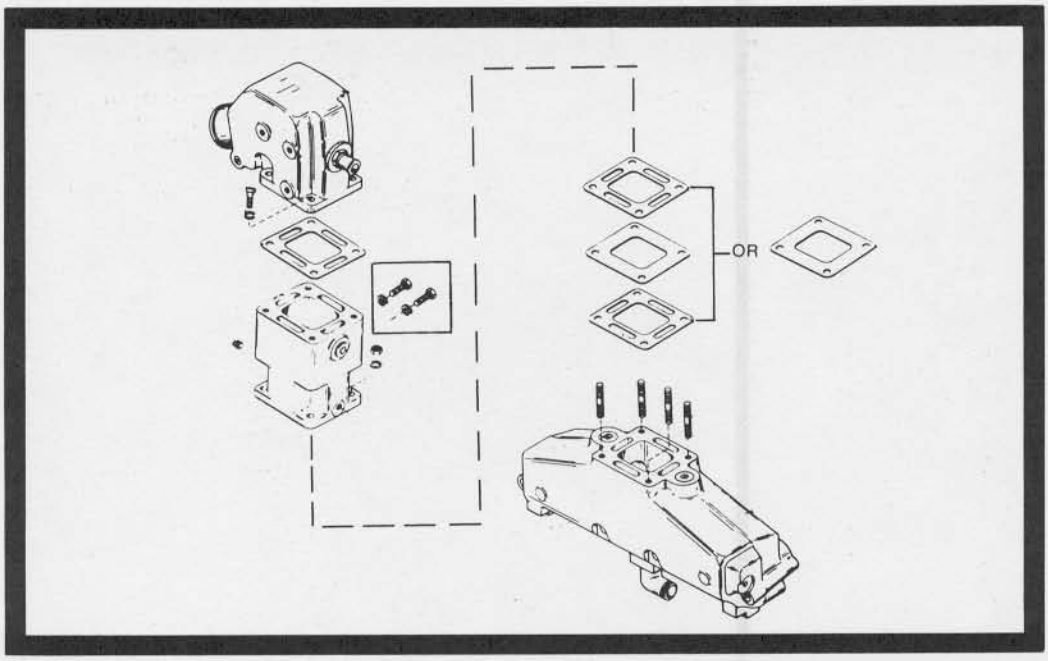


Stelling Exhaust "Header"

Installation

1. Using a new gasket, install manifold. Torque bolts to 30 lbs. ft. (41 N.m).
2. Reconnect exhaust and water hoses. Tighten clamps securely.
3. Reconnect battery cables securely.
4. Start engine and check for fuel, exhaust and water leaks.

EXHAUST SYSTEM



EXHAUST RISERS

C 7

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Exhaust Riser Kit Identification

Model	3 In. Riser Part No.	6 In. Riser Part No.
Production Models	93320A3	93322A3
MCM 370TRS (S.N. 6721527 and Below), 400TRS, 400 Cyclone	61811A4	53452A2
MCM 440/460 Cyclone MCM 420/575	Not Available	Not Available

Torque Specifiations

Fastener Lcoation	Lbs. Ft. (N.m)
Exhaust Elbow	20-25 (27-34)
Exhaust Riser	20-25 (27-34)

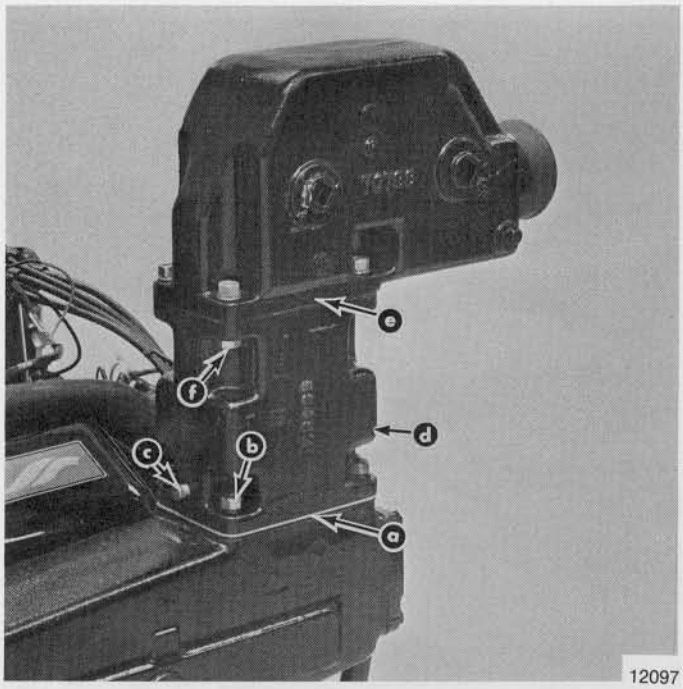
Sealants

SEALANTS	
92-34227--1	Quicksilver Perfect Seal

53452A2 6 In. Exhaust Riser Kit

Replacement

1. Drain exhaust elbow and exhaust manifold.
2. Remove fasteners. Remove elbow and riser.
3. Clean all gasket surfaces.
4. Using Perfect Seal on both sides of new gaskets, install riser and elbow.
5. Torque fasteners to specifications.
6. Tighten hose clamps securely.
7. Check for leaks after starting engine.



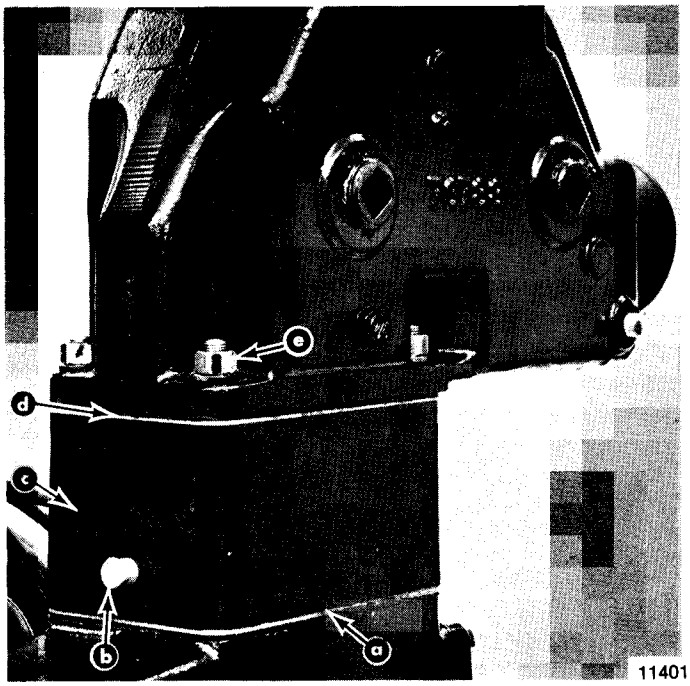
12097

a - Gasket
b - Lockwashers and Nuts (4)
c - Drain Plug - Down and Toward Front of Boat
d - 6 In. Riser
e - Gasket
f - Screws, Lockwashers and Nuts (4)

61811A4 3 In. Exhaust Riser Kit

Replacement

1. Drain exhaust elbow and exhaust manifold.
2. Remove fasteners, then elbow and riser.
3. Clean all gasket surfaces.
4. Using Perfect Seal on both sides of new gaskets, install riser and elbow.
5. Torque fasteners to specifications.
6. Tighten hose clamps securely.
7. Check for leaks after starting engine.



a - Gasket
b - Drain Plug - Down and Toward Front of Boat
c - 3 In. Riser
d - Gasket
e - Lockwashers and Nuts (4)

93320A3 3 In. Exhaust Riser Kit

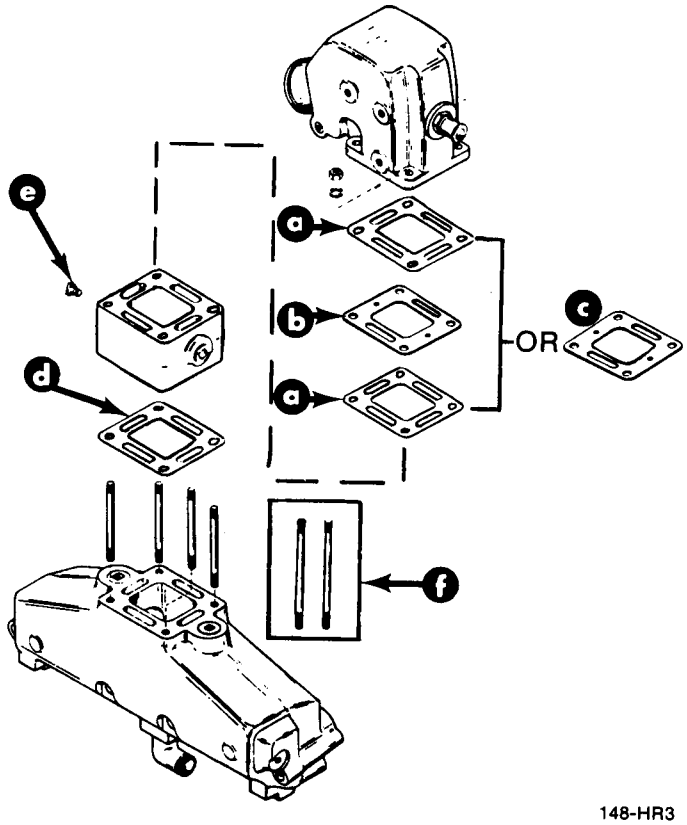
Replacement

1. Drain exhaust elbow and exhaust manifold.
2. Remove ignition amplifier or shift plate (MCM only.)
3. Remove fasteners, then elbow and riser.
4. Clean all gasket surfaces.
5. Using Perfect Seal on both sides of new gaskets, install riser and elbow.

IMPORTANT: Gaskets, restrictor plate (or separator plate and riser must be installed as shown.

IMPORTANT: If engine is equipped with closed cooling, stainless steel separator plate must be installed below 3 in. risers. If plate is installed above 3 in. riser, a steam pocket will form in exhaust manifolds during operation.

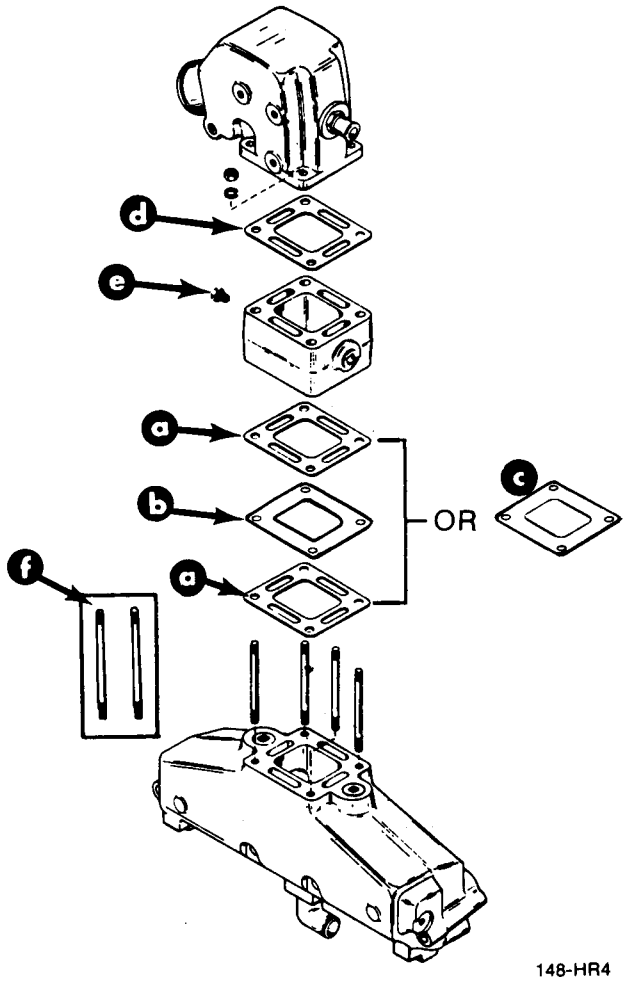
6. Torque fasteners to specifications.
7. **Elbow with ignition amplifier:** Reinstall ignition amplifier and wiring harness mounting bracket onto exhaust elbow using original attaching hardware. Be sure to reconnect amplifier and wiring harness ground wires to one of the attaching screws and that amplifier spacers are installed between amplifier and exhaust elbow. Tighten screws securely.
8. **Elbow with shift plate (MCM only):** Reinstall shift plate. Tighten fasteners securely. Readjust shift cables as outlined in "Stern Drive Service Manual".
9. Tighten hose clamps securely.
10. **Closed Cooling System:** Refill cooling system.
11. Check for leaks after starting engine.



148-HR3

a - Gasket (27-87105)
b - Stainless Steel Restrictor Plate
or C
c - Restrictor Gasket (27-41813) - DO NOT Use Perfect Seal on Gasket
d - Gasket (27-87105)
e - Drain Plug - Down and Toward Rear of Boat
f - Stud (2), Port Manifold with Remote Oil Filter - 6-1/2 In. (165mm)

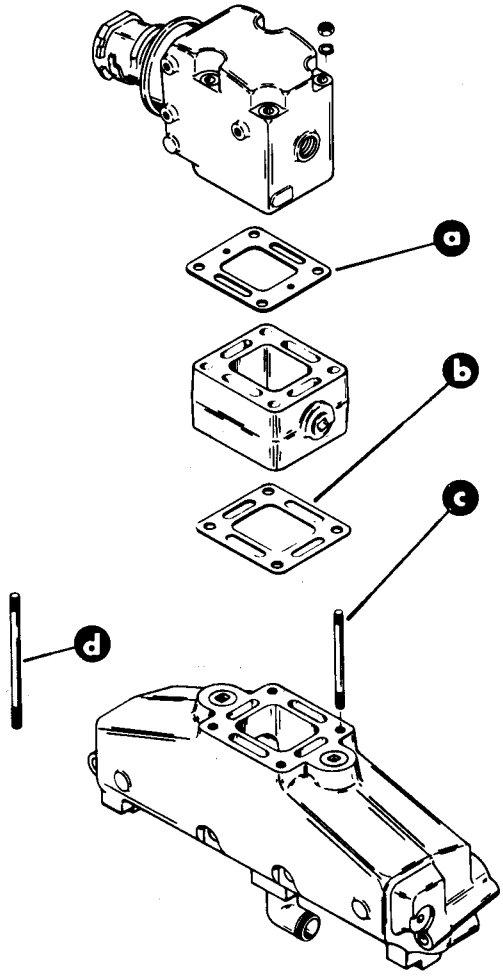
3 In. Exhaust Elbow Standard Cooling



148-HR4

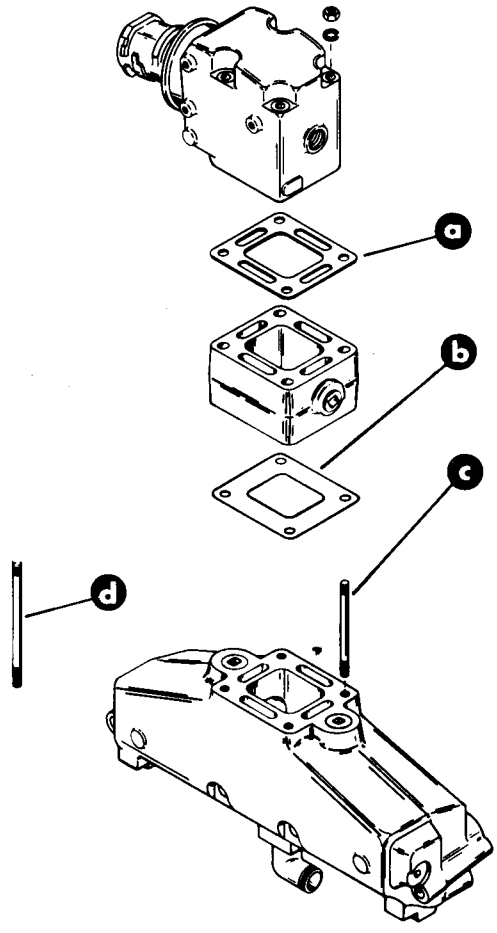
a - Gasket (27-87105)
b - Stainless Steel Separator Plate
or C
c - Separator Gasket (27-41811) - DO NOT Use Perfect Seal on Gasket
d - Gasket (27-87105)
e - Drain Plug - Down and Toward Rear of Boat
f - Stud (2), Port Manifold with Remote Oil Filter - 6-1/2 In. (165mm)

3 In. Exhaust Elbow Closed Cooling



a - Restrictor Gasket 27-41813
b - Gasket 27-87105
c - Stud (4), 9-9/16 In. (243mm)
d - Stud (2), Remote Oil Filter Bracket - 10-9/16 In. (268mm)

4 In. Exhaust Elbow Standard Cooling



a - Gasket 27-87105
b - Separator Gasket 27-41811
c - Stud (4), 9-9/16 In. (243mm)
d - Stud (2), Remote Oil Filter Bracket - 10-9/16 In. (268mm)

4 In. Exhaust Elbow Closed Cooling

93322A3 6 In. Exhaust Riser Kit

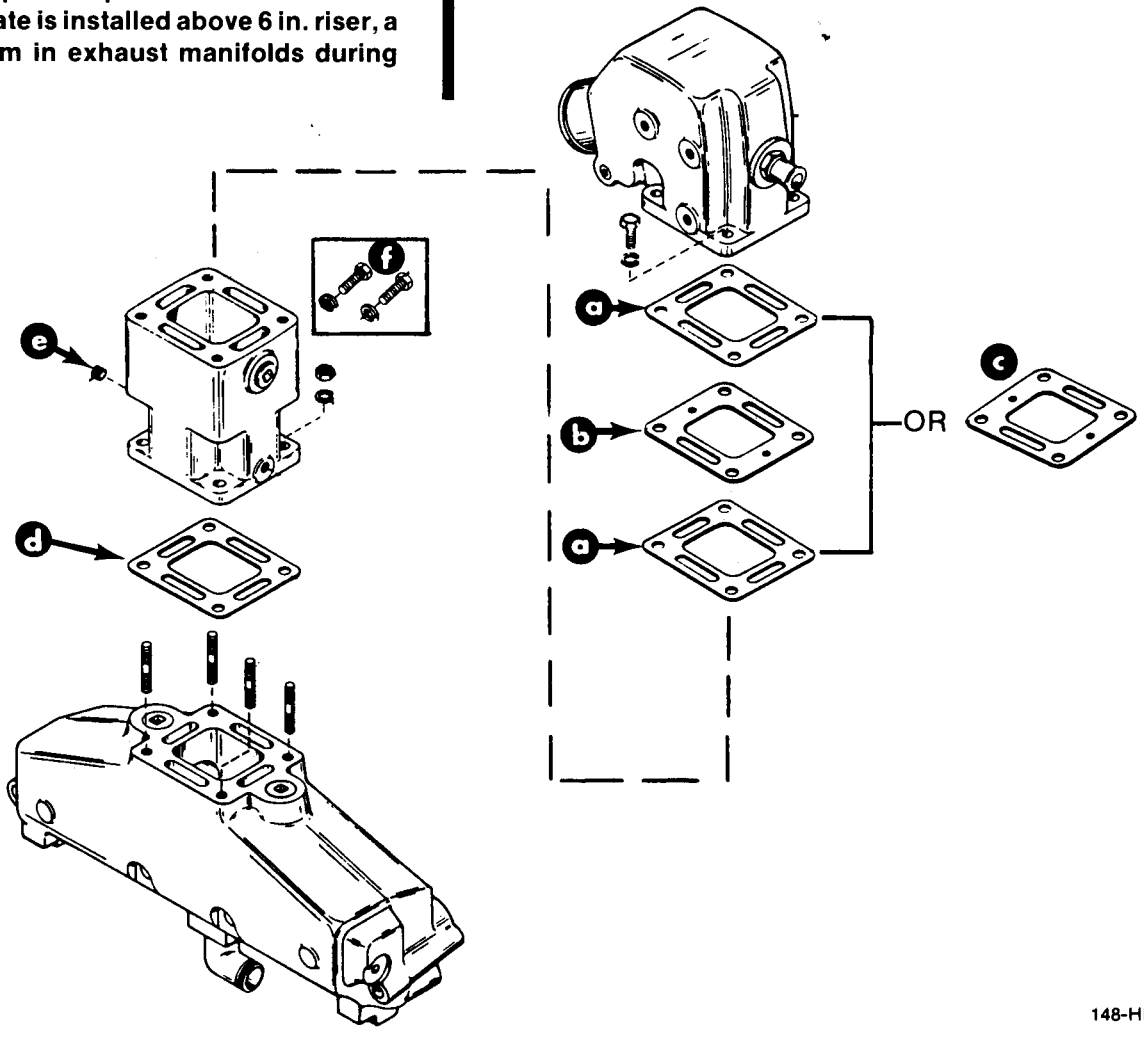
Replacement

1. Drain exhaust elbow and exhaust manifold.
2. Remove ignition amplifier or shift plate (MCM only).
3. Remove fasteners, then elbow and riser.
4. Clean all gasket surfaces.
5. Using Perfect Seal on both sides of new gaskets, install riser and elbow.

IMPORTANT: Gaskets, restrictor plate (or separator plate) and riser must be installed as shown.

IMPORTANT: If engine is equipped with closed cooling, stainless steel separator plate must be installed below 6 in. risers. If plate is installed above 6 in. riser, a steam pocket will form in exhaust manifolds during operation.

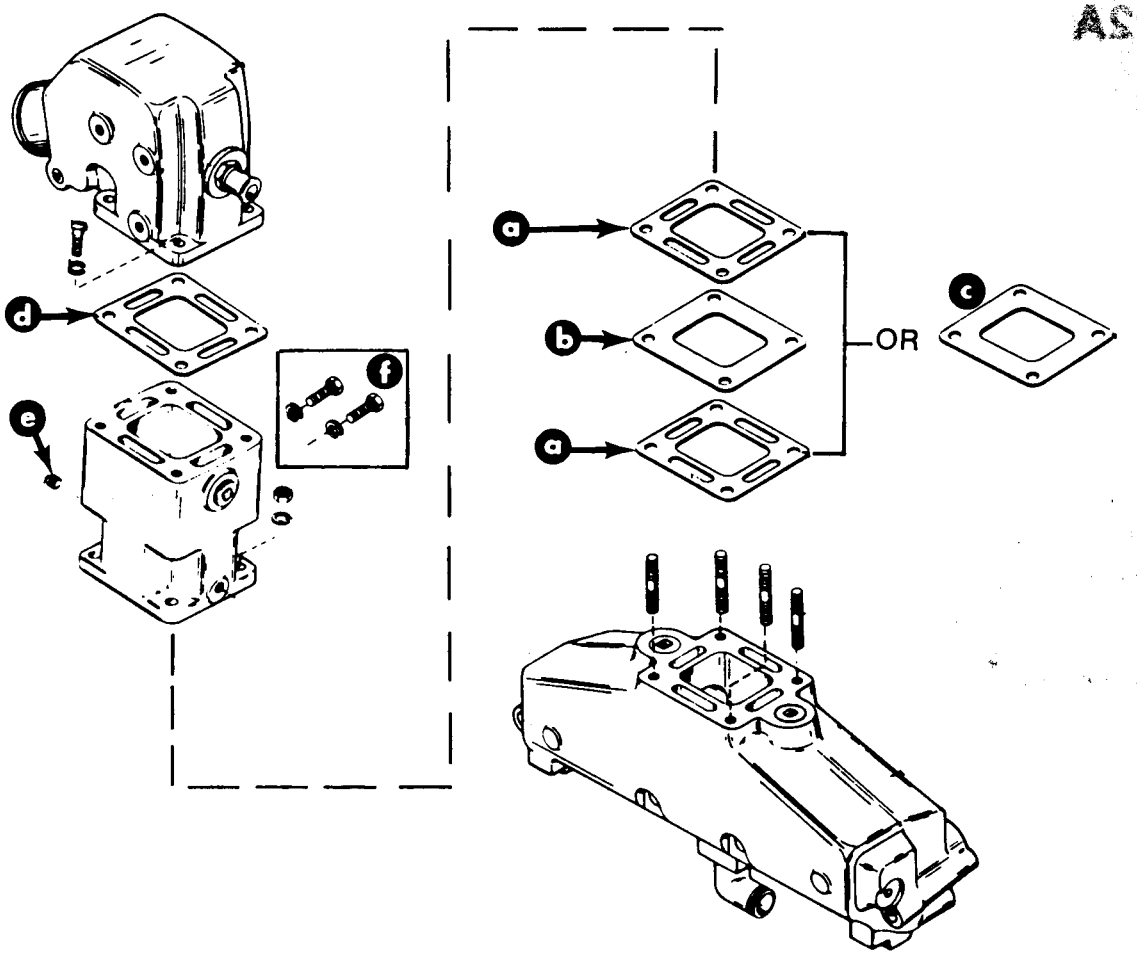
6. Torque fasteners to specifications.
7. **Elbow with ignition amplifier:** Reinstall ignition amplifier and wiring harness mounting bracket onto exhaust elbow using original attaching hardware. Be sure to reconnect amplifier and wiring harness ground wires to one of the attaching screws and that amplifier spacers are installed between amplifier and exhaust elbow. Tighten screws securely.
8. **Elbow with shift plate (MCM only):** Reinstall shift plate. Tighten fasteners securely. Readjust shift cables as outlined in "Stern Drive Service Manual".
9. Tighten hose clamps securely.
10. **Closed Cooling System:** Refill cooling system.
11. Check for leaks after starting engine.



148-HR5

a - Gasket (27-87105) — or C
b - Stainless Steel Restrictor Plate — or C
c - Restrictor Gasket (27-41813) - DO NOT Use Perfect Seal on Gasket
d - Gasket (27-87105)
e - Drain Plug - Down and Toward Rear of Boat
f - Screw (2), Starboard Riser with Wiring Harness Bracket - 1-1/8 In. (29mm)

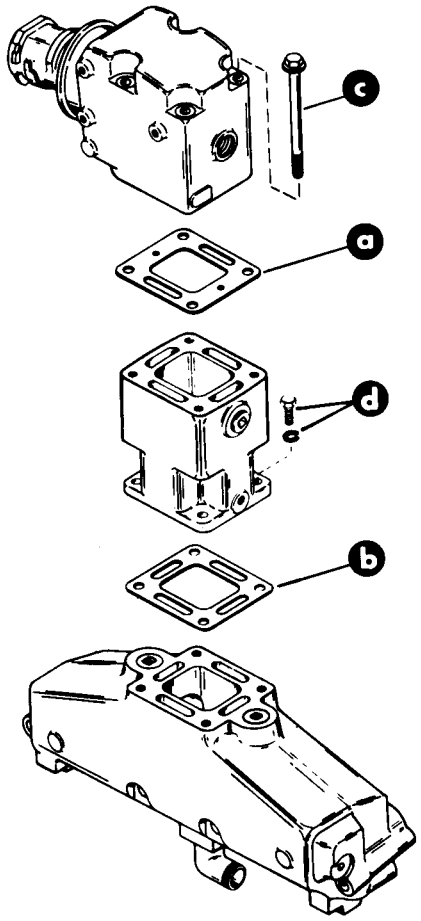
3 In. Exhaust Elbow Standard Cooling



148-HR6

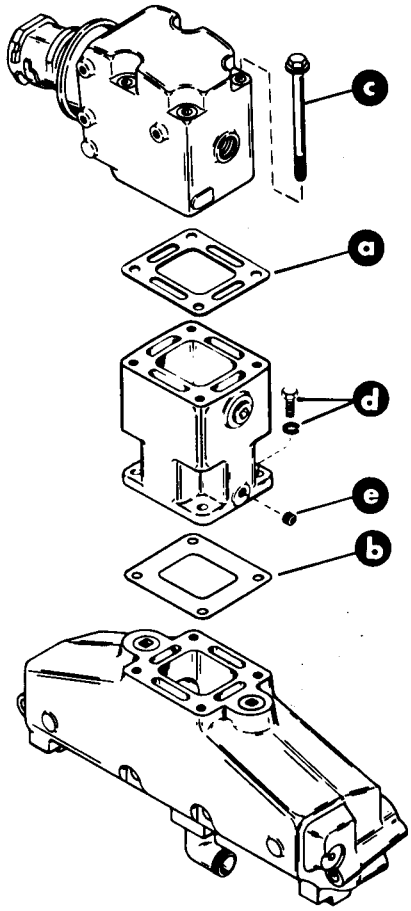
a - Gasket (27-87105)
b - Stainless Steel Separator Plate
— or C
c - Separator Gasket (27-41811) - DO NOT Use Perfect Seal on Gasket
d - Gasket (27-87105)
e - Drain Plug - Down and Toward Rear of Boat
f - Screw (2), Starboard Riser with Wiring Harness Bracket - 1-1/8 In. (29mm)

3 In. Exhaust Elbow Closed Cooling



a - Restrictor Gasket 27-41813
b - Gasket 27-87105
c - Long Bolts (4) - Elbow to Riser
d - Short Bolts and Lockwashers (4) - Riser to Manifold

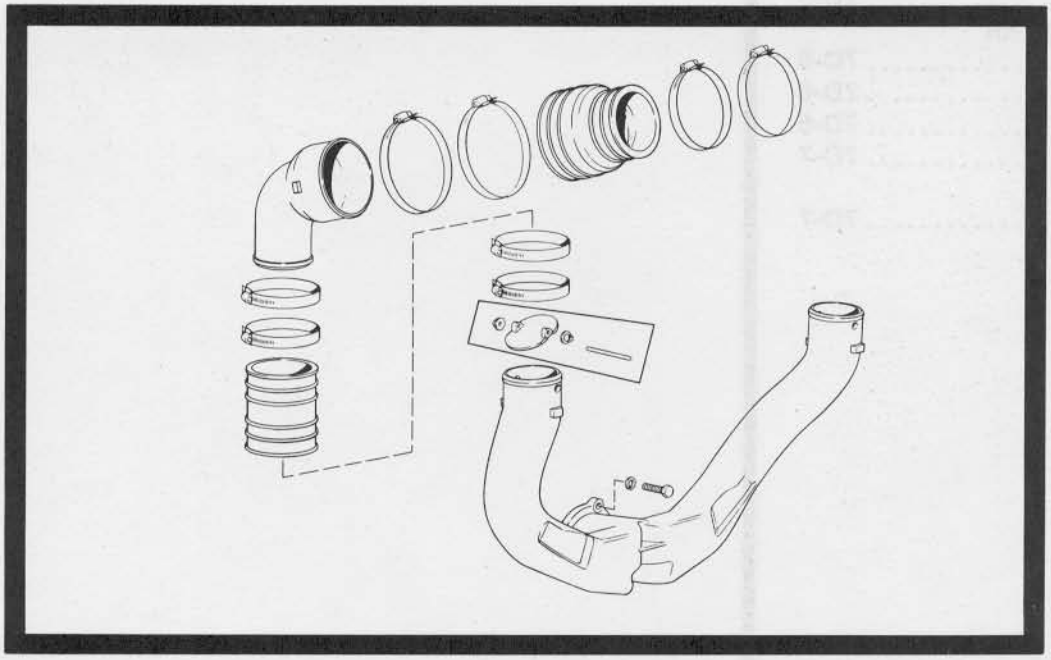
4 In. Exhaust Elbow Standard Cooling



a - Gasket 27-87105
b - Separator Gasket 27-41811
c - Long Bolts (4) - Elbow to Riser
d - Short Bolts and Lockwashers (4) - Riser to Manifold
e - Plug

4 In. Exhaust Elbow Closed Cooling

EXHAUST SYSTEM



EXHAUST COLLECTORS

D 7

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TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Block Off Plate	20-25 (27-34)
Exhaust Pipe to Gimbal Housing	20-25 (27-34)
Exhaust Pipe to Tee Pipe	20-25 (27-34)
Hose Clamps	Securely
Tee Pipe to Gimbal Housing	20-25 (27-34)
Upper Exhaust Pipe to Lower Exhaust Pipe	20-25 (27-34)
Water Shutter Screw/Nut	Securely

SEALANTS

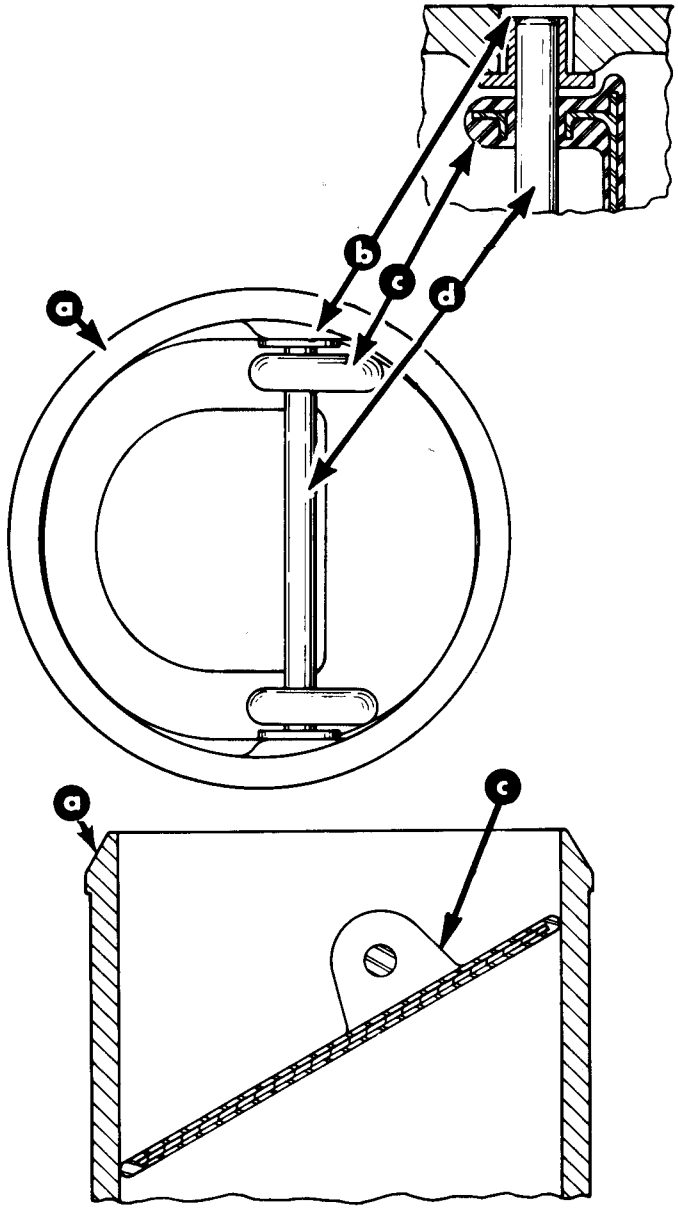
SEALANTS	
92-86166	Quicksilver Bellows Adhesive
92-34227	Quicksilver Perfect Seal

305/350 CID with Alpha One Drive

Shutter Replacement

IMPORTANT: Engine does not have to be removed to change shutters.

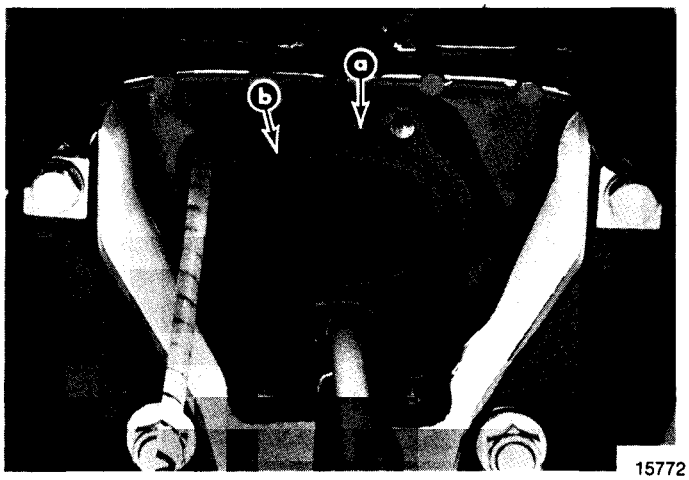
1. Loosen clamps and remove exhaust pipe elbow and exhaust hose.
2. Replace water shutter as shown.
3. Reinstall pipe elbow and hose. Tighten clamps securely.



a - Top of Pipe
b - Shoulder Bushing
c - Water Shutter - Install as Shown
d - Shaft

Exhaust System Component Replacement

1. To replace any component(s) in either exhaust system shown, the following must be adhered to:
   - All mating joint surfaces must be clean.
   - "O" ring must remain in groove to properly seal joint to prevent leakage.
   - Torque all screws and lockwashers to specifications.
   - Tighten all clamps securely.



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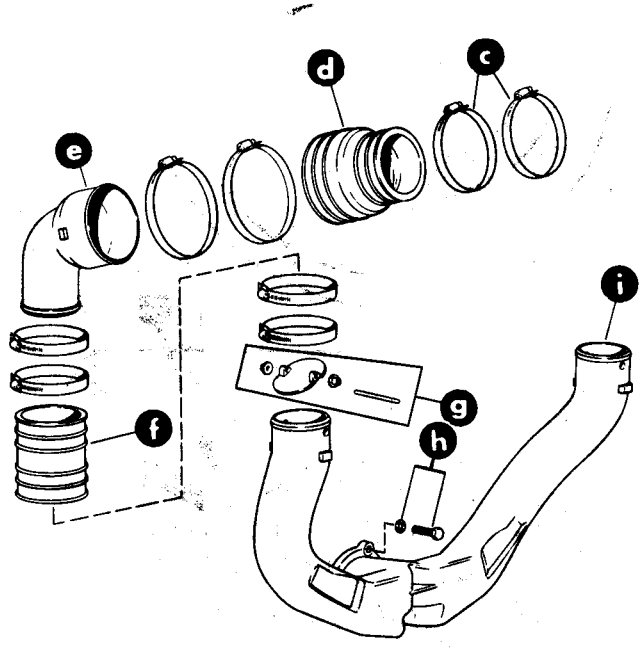
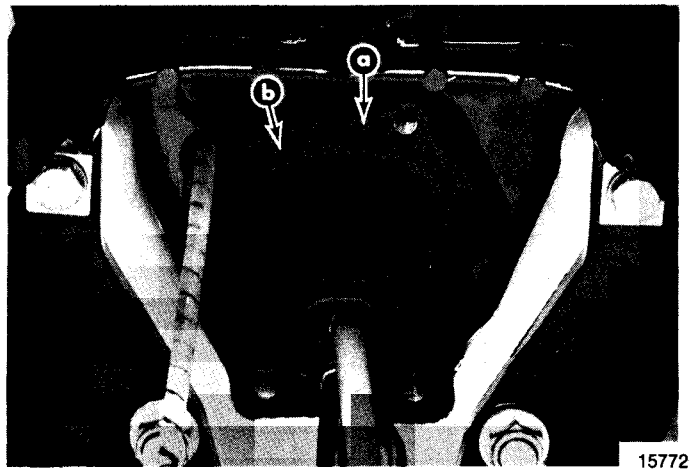


a - Mating Surface
b - "O" Ring
c - Clamps
d - Exhaust Bellows
e - Exhaust Pipe Elbow - Starboard: Casting No. 94443
Port: Casting No. 94444
f - Exhaust Hose
g - Water Shutters
h - Screws and Lockwashers - Torque to 20-25 Lbs. Ft. (27 - 34 N.m)
i - Exhaust Pipe

3 In. Exhaust System



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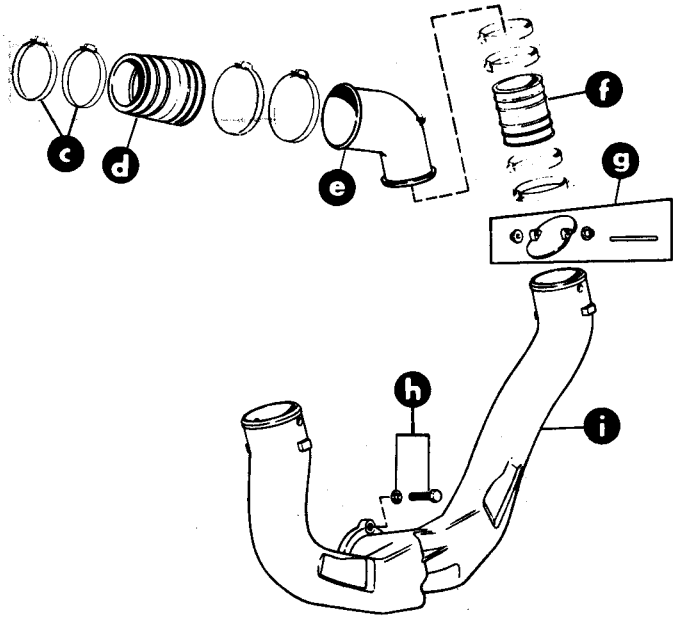


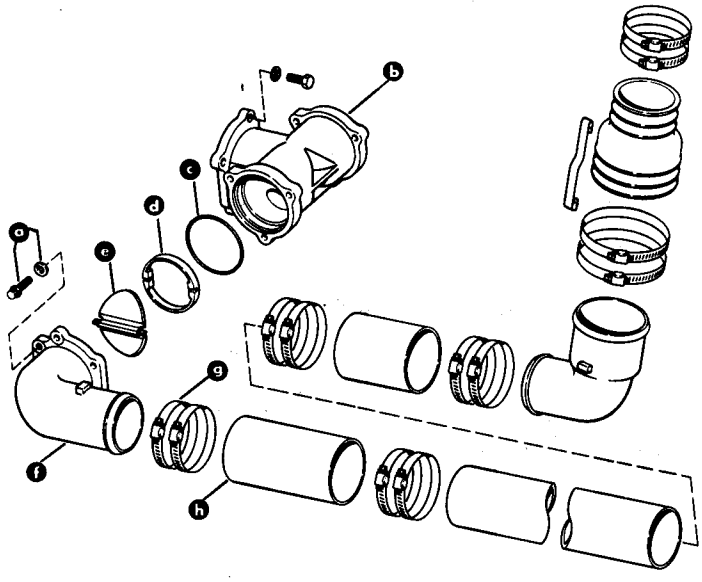
a - Mating Surface
b - "O" Ring
c - Clamps
d - Exhaust Bellows
e - Exhaust Pipe Elbow
f - Exhaust Hose
g - Water Shutters
h - Screws and Lockwashers - Torque to 20-25 Lbs. Ft. (27-34 N.m)
i - Exhaust Pipe

4 In. Exhaust System

305/350 CID with Alpha One Drive Driveshaft Extension Models

Shutter Replacement

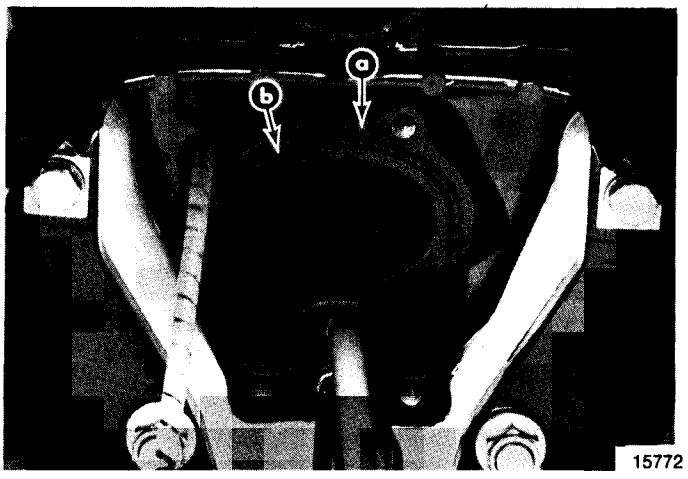
1. Loosen hose clamps on exhaust hose and remove screws and lockwashers.
2. Remove exhaust pipe elbow.
3. Remove water shutter, then retainer from tee pipe.
4. Install retainer, and shutter as shown.
5. Make sure mating surfaces are clean and "O" ring is in groove.
6. Reinstall exhaust pipe elbow with screws and lockwashers. Torque screws to 20-25 lbs. ft. (27-34 N.m). Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
7. Tighten clamps securely.



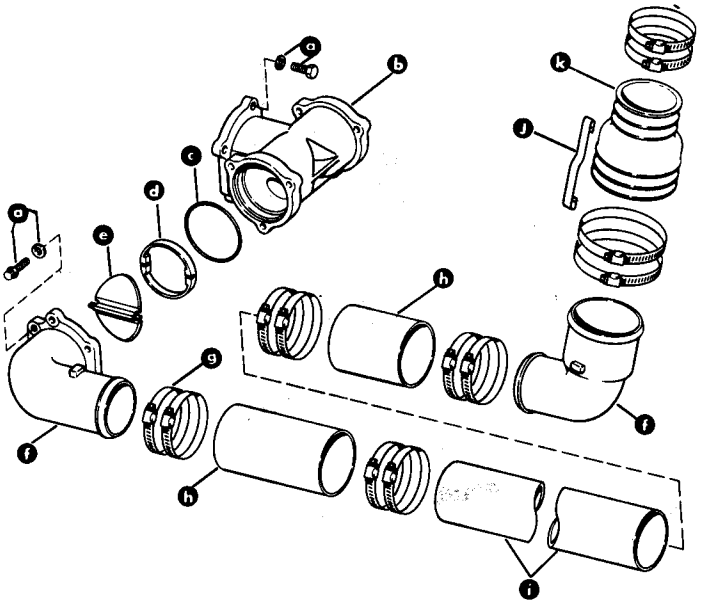
a - Screws and Lockwashers - Torque to 20-25 Lbs. Ft. (27-34 N.m)
b - Tee Pipe
c - "O" Ring
d - Retainer - Slots Facing Out
e - Water Shutter - Opens Toward Inside of Tee Pipe
f - Exhaust Pipe Elbow
g - Clamps
h - Exhaust Hose

Exhaust System Component Replacement

1. To replace any componet(s) in exhaust system, the following must be adhered to:
   - All mating joint surfaces must be clean.
   - "O" rings must remain in groove to properly seal joints to prevent leakage.
   - Torque all screws and lockwashers to specifications.
   - Tighten all clamps securely.



a - Mating Surface
b - "O" Ring

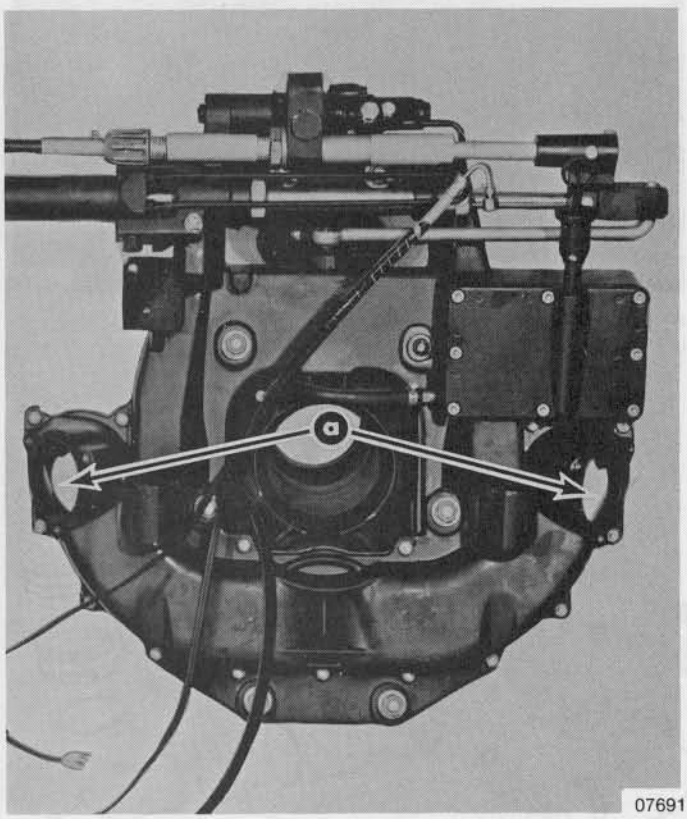


a - Screws and Lockwashers - Torque to 20-25 Lbs. Ft. (27-34 N.m)
b - Tee Pipe
c - "O" Ring
d - Retainer - Slots Facing Out
e - Water Shutter - Opens Toward Inside of Tee Pipe
f - Exhaust Pipe Elbow
g - Clamps
h - Exhaust Hose
i - Exhaust Tube
j - Ground Strap
k - Exhaust Bellows

MCM 330 B/W, MCM 230TR, MCM 260TR, 5.7 Litre TR, 7.4 Litre

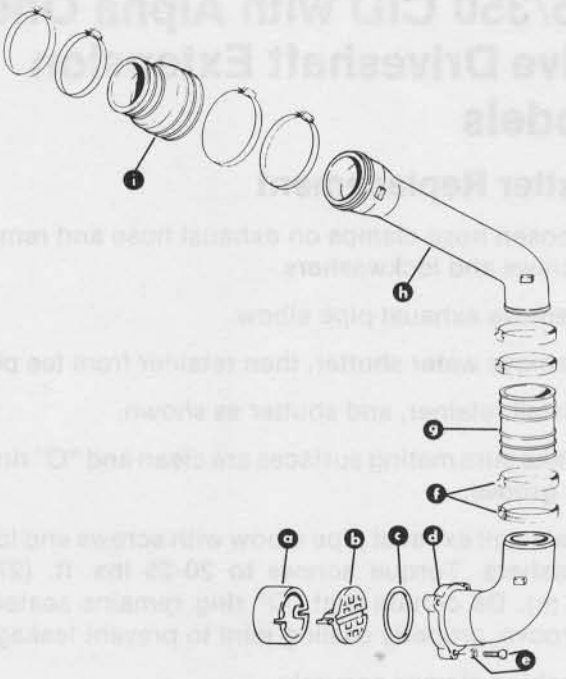
Exhaust System Component Replacement

1. To replace any componet(s) in exhaust system, the following must be adhered to:
   - All mating joint surfaces must be clean.
   - "O" rings must remain in groove to properly seal joints to prevent leakage.
   - Torque all screws and lockwashers to specifications.
   - Tighten all clamps securely.



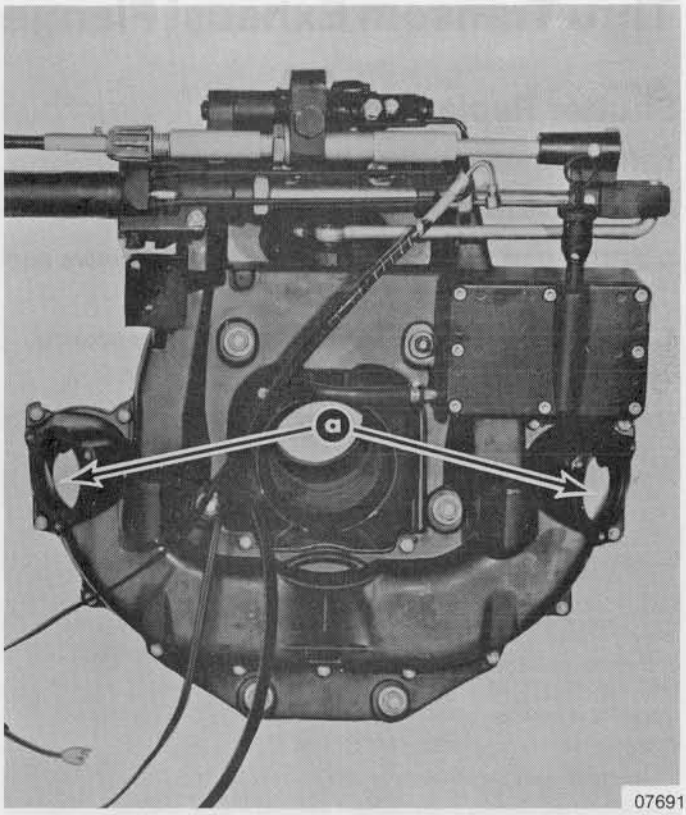
a - Mating Surfaces - Must Be Clean

Inner Transom Plate



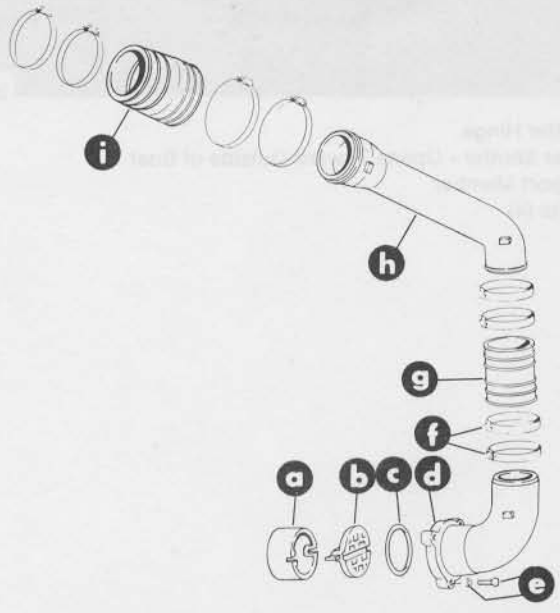
a - Retainer - Slots Toward Exhaust Pipe Elbow
b - Shutter - Opens Toward Transom Plate
c - "O" Ring
d - Exhaust Pipe Elbow
e - Screws and Lockwashers (3 Per Side) - Torque to 20-25 Lbs. Ft. (27-34 N.m)
f - Clamps
g - Exhaust Hose
h - Exhaust Pipe - Casting No. 44141
i - Exhaust Bellows

Exhaust System Components 3 In. Exhaust System



a - Mating Surfaces - Must Be Clean

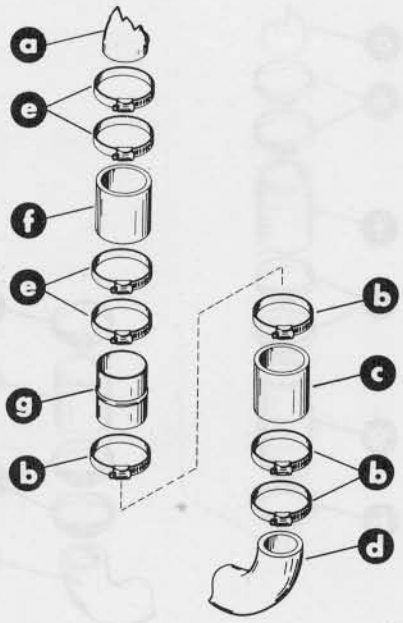
Inner Transom Plate



a - Retainer - Slots Toward Exhaust Pipe Elbow
b - Shutter - Opens Toward Transom Plate
c - "O" Ring
d - Exhaust Pipe Elbow
e - Screws and Lockwashers (3 Per Side) - Torque to 20-25 Lbs. Ft. (27-34 N.m)
f - Clamps
g - Exhaust Hose
h - Exhaust Pipe - Casting No. 44391
i - Exhaust Bellows

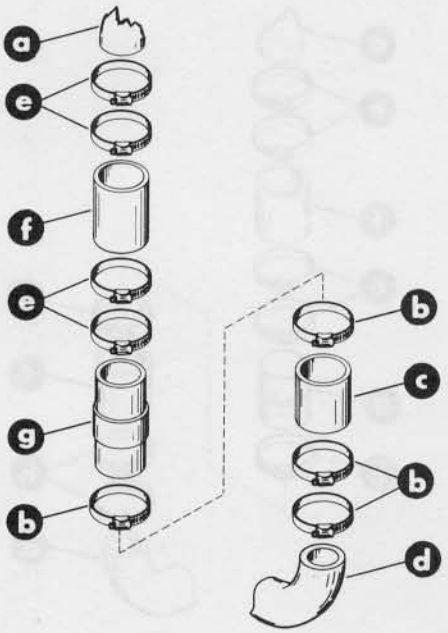
Exhaust System Components 4 In. Exhaust System

3 In. Exhaust Hose Extension Kit 32-62364A1



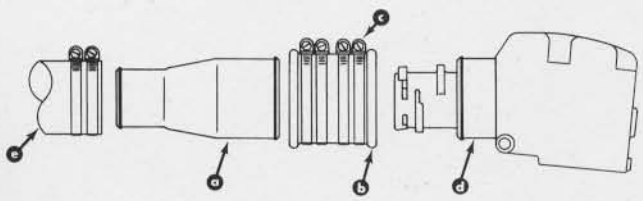
a - Original Exhaust Elbow or Exhaust Tube
b - Original Clamps
c - Original Exhaust Bellows
d - Original Exhaust Pipe
e - Clamps - From Kit
f - Exhaust Hose [3-1/4 In. (83mm)] - From Kit
g - Exhaust Tube [3 In. (76m)] - From Kit

6 In. Exhaust Hose Extension Kit 32-59077A1



a - Original Exhaust Elbow or Exhaust Tube
b - Original Clamps
c - Original Exhaust Bellows
d - Original Exhaust Pipe
e - Clamps - From Kit
f - Exhaust Hose [4 In. (102mm)] - From Kit
g - Exhaust Tube [4-13/16 In. (148m)] - From Kit

4 In. to 3 In. Exhaust Reducer Kit 44349A1

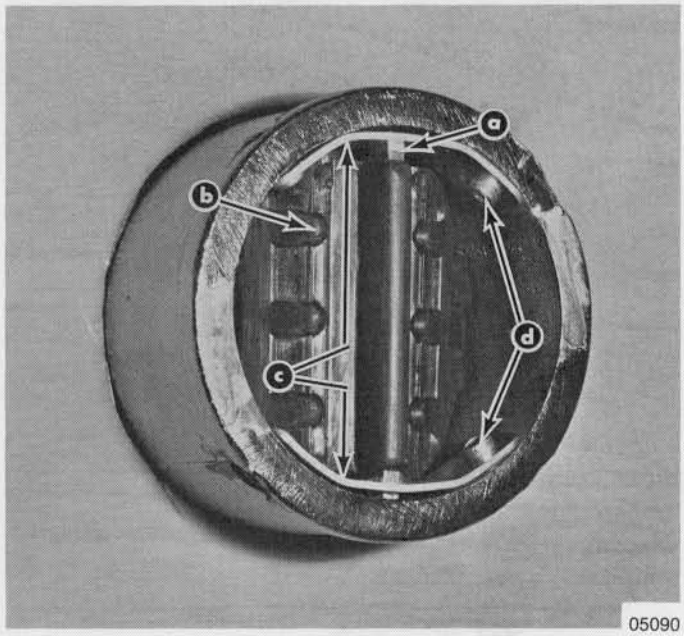


a - Reducer
b - Exhaust Tube
c - Hose Clamp
d - Exhaust Elbow
e - Exhaust Hose

Thru Transom Exhaust Flange

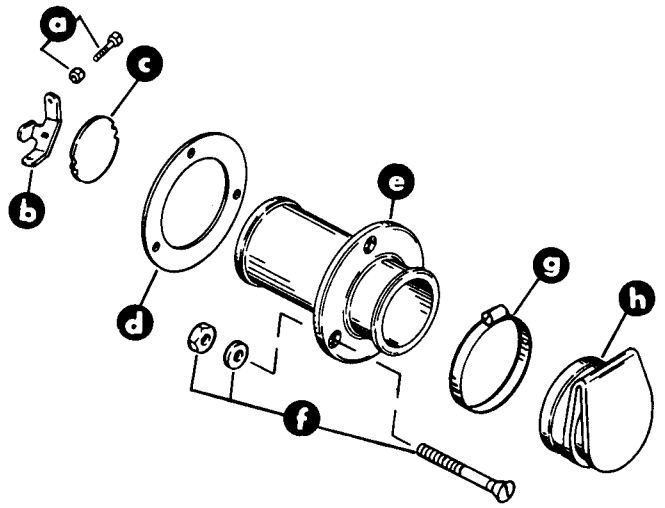
Shutter Replacement

1. Remove exhaust hose clamps, then hose.
2. Chisel rivets away from both support members.
3. Install new shutter as shown. Tighten screws and nut securely.
4. Reinstall exhaust hose. Tighten clamps securely.



a - Shutter Hinge
b - Water Shutter - Opens Toward Outside of Boat
c - Support Member
d - Rivets (4)

Component Replacement

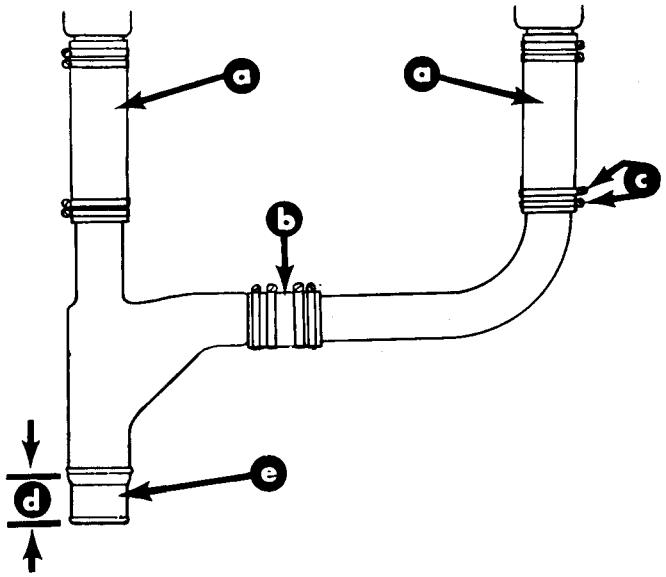


AC0089

a - Screw and Nut (4)
b - Support Member
c - Water Shutter
d - Gasket
e - Exhaust Flange
f - Screws, Washers and Nuts (3)
g - Clamp
h - Cover ("Flapper")

MIE 230, MIE 260, 5.0 Litre, 5.7 Litre, MIE 5.7 Ski Single Exhaust Kit 48640A2

IMPORTANT: If using a 2 into 1 collector system on an MIE 340, collector outlet and related hose(s) and fitting(s) must be a minimum of 5 in. I.D. to achieve optimum performance.

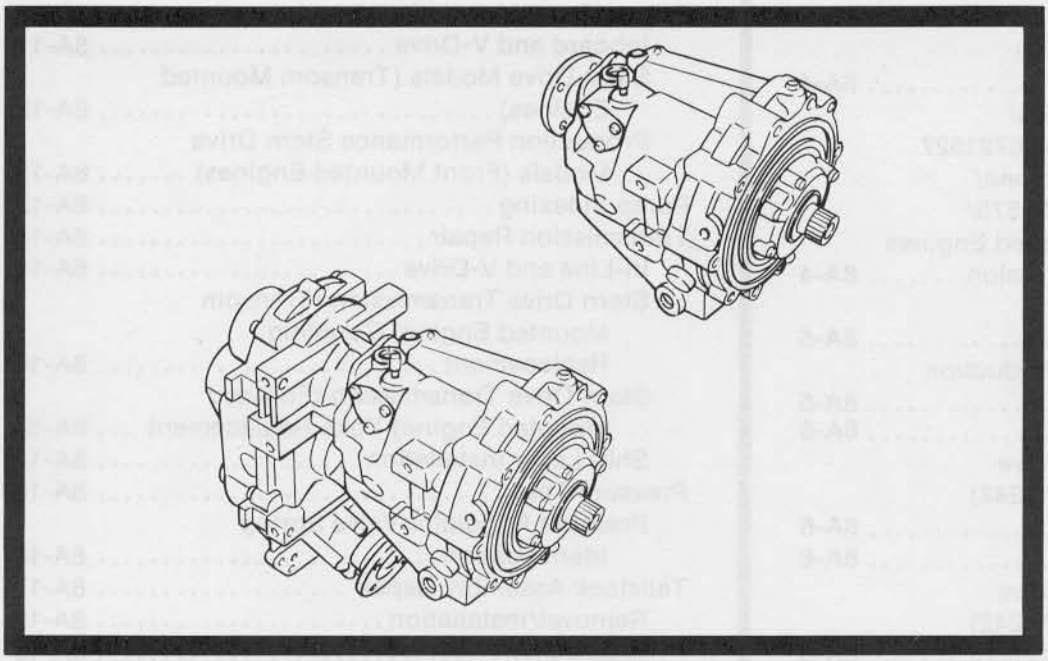


a - Hose - Cut to Fit
b - Hose - 4 In. (102mm) Long
c - Clamps - 2 At Each Connection, Tighten Securely
d - Cut 2-3/8 In. (60mm) From End of "Y" Pipe to Allow Use of 4 In. (102mm) Exhaust Hose
e - Connect to Thru Transom Exhaust Hose

DRIVE SYSTEMS

8

A



VELVET DRIVE®

(BORG-WARNER) TRANSMISSION

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Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Drain Plug (Bushing)	25 (34)	
Fluid Hose to Bushing	25 (34)	
Pump Housing to Adaptor		204-264 (23-29)
Rear Mounts to Transmission	45 (61)	
Shift Lever to Valve		96-132 (11-15)
Tailstock to Transmission (MCM Models)	50 (68)	
Transmission to Flywheel Housing	50 (68)	
Yoke to Output Shaft (MCM Forward Mounted Engine Only)	100-200 (136-271)	
Neutral Start Switch	8-11 (11-14)	

Tools/Lubricants/Sealants

Part Number	Description
91-34569A1	Slide Hammer Puller
92-86154A1	Quicksilver 2-4-C Marine Lubricant
92-34227	Quicksilver Perfect Seal
92-32609-1	Quicksilver Loctite
92-86166	Quicksilver Bellows Adhesive
92-91601-1	Quicksilver RTV Sealer

Specifications

TRANSMISSION FLUID SPECIFICATION
Use only 10 wt. tractor hydraulic fluid meeting the C3/To-2 specification (preferably Mobil 423, Chevron, or Citgo). NOTE: Citgo has two grades of fluid meeting the C3/To-2 specification; Citgo tractor hydraulic fluid, and Citgo multi-purpose Dexron II — both are acceptable for use.

TRANSMISSION FLUID CAPACITY (APPROXIMATE)		
Engine Model	**In-Line Transmission Qts. (litres)**	**V-Drive Transmission Qts. (litres)**
MIE 230/260 340, 5.0 Litre, 5.7 Litre, 7.4 Litre	1:1 - 2 (1.9) 1.5:1 to 2.91:1 - 3 (2.8)	4-1/2 (4.3)
MCM 330 (B-W)/ 7.4 Litre TR Production Performance Models	2 (1.9)	

PRESSURE SPECIFICATION - TRANSMISSIONS USING WHITE SPRING (PART NO. 72N-242) (NOTE 1)				
Engine RPM	**Neutral Gear PSI (kPa)**		**Forward or Reverse Gear PSI (kPa)**	
	Min.	**Max.**	**Min.**	**Max.**
200			70 (482.6)	
500	90 (620.5)	120 (827.4)	90 (620.5)	120 (827.4)
2000			100 (689.5)	125 (861.8)

NOTE 1: Refer to "Identification" for starting serial numbers of transmissions with white spring.

PRESSURE SPECIFICATION - TRANSMISSIONS USING BLACK SPRING (PART NO. 71-242)				
Engine RPM	**Neutral Gear PSI (kPa)**		**Forward or Reverse Gear PSI (kPa)**	
	Min.	**Max.**	**Min.**	**Max.**
200			70 (482.6)	
500	115 (792.9)	135 (930.8)	115 (792.9)	135 (930.8)
2000			125 (861.8)	160 (1103.2)

IN-LINE TRANSMISSION OUTPUT SHAFT ROLLING TORQUE (Note 1)		
Model	**Ratio**	**Lbs. In. (N.m)**
10-17 or 10-18	1:1	50 (68) Max.
10-17 or 10-18	1.52:1	55 (75) Max.
10-17 or 10-18	1.91:1	60 (81) Max.
10-17 or 10-18	2.57:1	65 (88) Max.
10-17 or 10-18	2.91:1	70 (95) Max.

NOTE 1: Transmission is not installed on engine, no fluid in transmission. Use torque wrench and socket on coupling nut.

Identification

The transmission identification plate is located on the top left side of the transmission. Refer to charts following to determine engine and transmission combinations.

a - Model Number
b - Ratio (In Forward)
c - Serial Number
d - Identification Plate Model Color Code

Transmission Identification Plate

14690

MIE 230/260/5.0 Litre/5.7 Litre/5.7 Ski, MCM 370TRS (FORWARD MOUNTED ENGINES S.N. 6721528 and Above) MODELS WITH IN-LINE TRANSMISSION				
Ratio In Forward Gear (Note 1)	**Identification Plate Color Code**	**Warner Gear Model Number**	**Old Warner Gear Model Number**	**Mercury Marine Part Number**
1:1 (Note 3)	Red	10-17-000-004	AS1-71CBR	47805
1.52:1	Red	10-17-000-006	AS2-71CR	47806
1.91:1 (Note 2)	Red	10-17-000-008	AS7-71CR	47807
2.57:1	Red	10-17-000-012	AS14-71CR	47808
2.91:1	Red	10-17-000-014	AS15-71CR	47809

NOTE 1: This ratio is shown on identification plate. Ratio may be rounded off in some cases.
2: The propeller shaft will turn opposite the engine rotation (when in forward gear) on this transmission.
3: MCM engine use 1:1 gear ratio only.

MIE 305/350 CID MODELS WITH V-DRIVE TRANSMISSION				
Ratio In Forward Gear (Note 1)	**Identification Plate Color Code**	**Warner Gear Model Number**	**Assembly Numbers (Note 2)**	**Mercury Marine Part Number**
1:1 (Note 3)	Red	10-04-000-009	10-04-410-001 (13-08-410-009)	60953
1.51:1	Red	10-04-000-011	10-04-410-001 (13-08-410-011)	60588
1.99:1	Red	10-04-000-002	10-04-410-001 (13-08-410-002)	60954
2.49:1	Red	10-04-000-005	10-04-410-001 (13-08-410-005)	60955
3.14:1	Red	10-04-000-007	10-04-410-001 (13-08-410-007)	60956

NOTE 1: Ratio is shown on identification plate. Ratio may be rounded off in some cases.
2: 10-410-001 is part number for the front box (forward and reverse gear). 13-08-410-_____is part number for the V-Drive box.
3: MCM Engines uses 1:1 ratio only.

IMPORTANT: MCM 575 have transmissions with green identification plate, but are specially modified by Mercury Marine.

MIE 340, 7.4 Litre, MCM 320 EFI, MCM 300 Tempest TRS/370TRS - S.N. 6721527 and Below/ 400TRS/400 Cyclone/MCM 420/MCM 575/440 Cyclone/460 Cyclone (FORWARD MOUNTED ENGINES) MODELS WITH IN-LINE TRANSMISSION				
Ratio In Forward Gear (Note 1)	**Identification Plate Color Code**	**Warner Gear Model Number**	**Old Warner Gear Model Number**	**Mercury Marine Part Number**
1:1 (Note 3)	Green	10-18-000-002	AS11-72CR	47810
1.52:1	Green	10-18-000-004	AS12-72CR	47811
1.91:1 (Note 2)	Green	10-18-000-006	AS17-72CR	47812
2.57:1	Green	10-18-000-010	AS14-72CR	47813
2.91:1	Green	10-18-000-012	AS15-72CR	47814

NOTE 1: Ratio is shown on identification plate. Ratio may be rounded off in some cases.
2: Propeller shaft will turn opposite engine rotation (when in forward gear) on this transmission.
3: MCM engines use 1:1 ratio only.

MIE 340 MODELS WITH V-DRIVE TRANSMISSION				
Ratio In Forward Gear (Note 1)	**Identification Plate Color Code**	**Warner Gear Number**	**Assembly Numbers (Note 2)**	**Mercury Marine Part Number**
1:1	Green	10-05-000-009	10-05-410-001 (13-08-410-009)	60958
1.51:1	Green	10-05-000-011	10-05-410-001 (13-08-410-011)	60959
1.99:1	Green	10-05-000-002	10-05-410-001 (13-08-410-002)	60960
2.49:1	Green	10-05-000-005	10-05-410-001 (13-08-410-005)	60961
3.14:1	Green	10-05-000-007	10-05-410-001 (13-08-410-007)	60962

NOTE 1: Ratio is shown on identification plate. Ratio may be rounded off in some cases.
2: 10-410-001 is the part number for the front box (forward and reverse gear). 13-08-410-_____is the part number for the V-Drive box.

TRANSOM MOUNTED MCM and PRODUCTION PERFORMANCE MODELS				
Ratio In Forward Gear (Note 1)	**Identification Plate Color Code**	**Warner Gear Model Number**	**Old Warner Gear Model Number**	**Mercury Marine Part Number**
1:1	Green	10-18-000-014	AS20-72CR	47754A9
1:1 (Note 2)	Red	10-17-000-016	AS20-71CR	47753

NOTE 1: Ratio is shown on identification plate. Ratio may be rounded off in some cases.
2: MCM 330 (B-W) S.N. 6760343 and above use this transmission.

IN-LINE TRANSMISSIONS

WHITE PRESSURE REGULATOR VALVE SPRING (PART NUMBER 72N-242) IDENTIFICATION (NOTE 1)		
Ratio In Forward Gear	**Warner Gear Model Number**	**Starting Serial Number and Above**
1:1	10-17-000-004	241
1.52:1	10-17-000-006	3767
1.91:1	10-17-000-008	3697
2.57:1	10-17-000-012	1904
2.91:1	10-17-000-014	2708
1:1 (Note 2)	10-17-000-016	143
1:1	10-18-000-002	2152
1.52:1	10-18-000-004	2023
1.91:1	10-18-000-006	2880
2.57:1	10-18-000-010	829
2.91:1	10-18-000-012	1282
1:1 (Note 3)	10-18-000-014	2784

NOTE 1: Sealing rings (instead of bushings) used in these transmissions also.
2: MCM 330 (B-W) (S.N. 6760343 and above) only.
3: MCM 330 (B-W) (S.N. 6760342 and below) and all Hi-Performance Stern Drive Models.

V-DRIVE TRANSMISSIONS

WHITE PRESSURE REGULATOR VALVE SPRING (PART NUMBER 72N-242) IDENTIFICATION (NOTE 1)		
Ratio In Forward Gear	**Warner Gear Model Number**	**Starting Serial Number and Above**
1:1	10-04-000-009	1069
1.51:1	10-04-000-011	2111
1.99:1	10-04-000-002	3172
2.49:1	10-04-000-005	463
3.14:1	10-04-000-007	480
1:1	10-05-000-009	703
1.51:1	10-05-000-011	153-156, 643-683, 1200
1.99:1	10-05-000-002	1108
2.49:1	10-05-000-005	340-347, 354
3.14:1	10-05-000-007	314

NOTE 1: Sealing rings (instead of bushings) used in these transmissions also.

Important Information

Shift Control and Cables

⚠CAUTION

Shift control and shift cable must position transmission shift lever exactly as stated in this manual, or transmission, as a result of improper shift lever positioning, will not be covered by Warner Gear Warranty.

IMPORTANT: Warner Gear Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, or if shift lever is repositioned or changed in any manner.

Remote control used must position transmission shift lever over the letter "F" embossed on transmission case when remote control is placed in forward gear position. Transmission failure will occur if transmission shift lever is positioned over the letter "R" and the wrong rotation propeller is used to propel boat forward.

Remote control also must provide a total shift cable travel (at transmission end) of at least 2-3/4 in. (70mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.

Engine

Engine rotation is indicated on engine specifications and serial number decal on rocker arm cover. Engine rotation is described when observed from the rear of the engine (transmission end) looking forward (water pump end).

Installed angle of MIE inboard transmission and engine should not exceed a maximum of 18° of the water line.

Transmission

Transmission gear ratio (in forward gear) is marked on transmission identification plate, which is located on the port (left) side of transmission. Transmission output shaft rotation and propeller rotation required is indicated on a decal on transmission case. Transmission rotation is described when viewed from the rear of transmission with transmission in forward gear selector position.

On MIE engines equipped with in-line transmissions having 1:1, 1.5:1, 2.5:1 or 3:1 gear ratios, transmission output shaft rotation is the same as engine rotation with transmission in forward gear. If engine rotation is "LH" (CCW), a "LH" propeller is required. If engine rotation if "RH" (CW), a "RH" propeller is required.

On MIE engines equipped with in-line transmissions having 2:1 gear ratio, transmission output shaft rotation is opposite of engine rotation with transmission in forward gear. If engine rotation is "LH" (CCW), a "RH" propeller is required. If engine rotation is "RH"(CW), a "LH" propeller is required.

ON MIE engines which are equipped with V-drive transmissions, transmission output shaft rotation is the same as engine rotation with transmission in forward gear. Because of reversed engine mounting position, however, a "RH" propeller is required, if engine is "LH" (CCW) rotation; or "LH" rotation propeller is required, if engine is "RH" (CW) rotation.

1. DO NOT start or crank engine without fluid in transmission.
2. Use only recommended fluid in transmission.
3. Except in an emergency, never shift transmission at engine speeds above 1000 RPM.
4. Free wheeling of one propeller (in a twin engine boat), at trolling speeds, will not cause damage to the transmission; however, boat operation above trolling speed should be avoided. Be sure proper fluid level exists before free wheeling propeller.
5. DO NOT paint shift lever poppet ball and spring. An accumulation of paint here will prevent proper action of the detent.
6. Always replace oil cooler and hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and hoses and will gradually flow back into the fluid system and damage transmission.
7. Always use specified oil cooler, hoses and fittings. Hoses must be at least 13/32 in. (10.3mm) I.D. Oil cooler, hoses and fittings must be sufficient size to maintain transmission fluid (in sump) at 140° - 190° F (60° - 88° C).

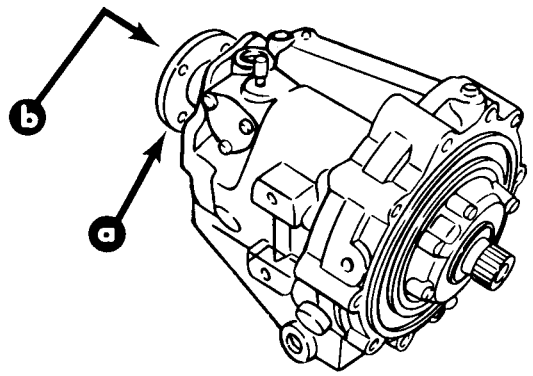
Propeller

Propeller rotation is described when observed from the rear of the boat (stern) looking forward (bow end). The term "left-hand" ("LH") refers to rotation in the counterclockwise (CCW) direction. The term "right-hand" ("RH") refers to rotation in the clockwise (CW) direction. A "LH" propeller will move the boat forward when rotated counterclockwise. A "RH" propeller will move the boat forward when rotated clockwise. Propeller rotation is not necessarily the same as engine rotation.

Special Replacement Part Information

MCM 330 (B-W), 7.4 Litre, MCM Production Performance Models

The standard 1:1 transmission (10-18 or 10-17) used on inboard applications utilizes a threaded pinion cage and output shaft. The flanged coupling, used for inboard applications, is secured to threaded shaft with a nut.

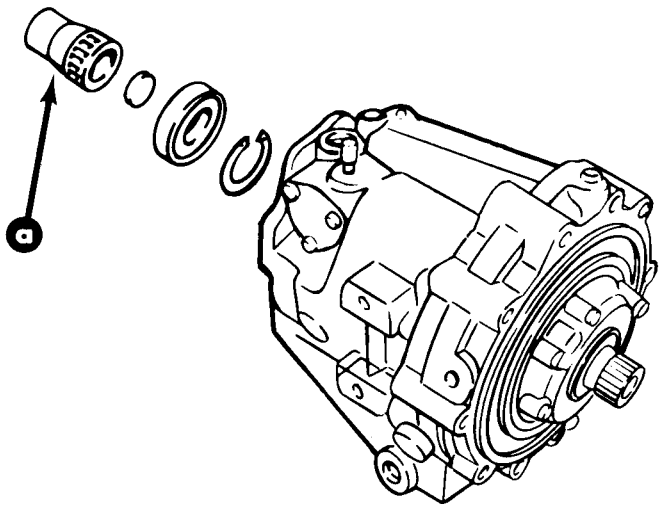


a - Flanged Coupling
b - Nut (Hidden)

Standard Inboard Transmission

Warner Gear installs a splined pinion cage and output shaft in transmissions used for stern drive applications (for models listed preceding). A splined coupling is then used on transmission output shaft in these applications.

This special pinion cage and output shaft is not shown in Warner Gear parts lists at this time. Refer to chart for Warner Gear part number when ordering new part. Refer to MerCruiser parts list for ordering splined coupling, plug, bearing and snap ring.



a - Splined Coupling

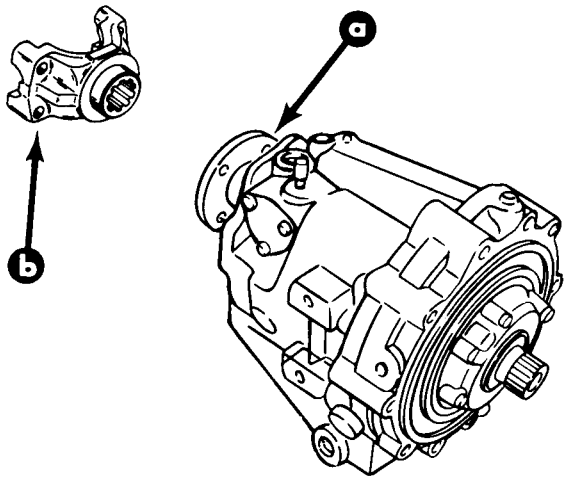
Stern Drive Transmission

WARNER GEAR PART NUMBERS FOR SPECIAL PINION CAGE AND OUTPUT SHAFT

Transmission Model Number	When Bushings Are Used	When Sealing Rings Are Used
10-18-000-014	10-18-659-002	10-18-659-014
10-17-000-016	10-17-659-002	10-17-659-020

MCM Production Performance (Forward Mounted) Engines

The flanged coupling is removed from the standard 1:1 transmission (10-18). A yoke is installed so that the drive shaft can be bolted to the output shaft of the transmission. Part number for yoke is in MerCruiser parts lists.



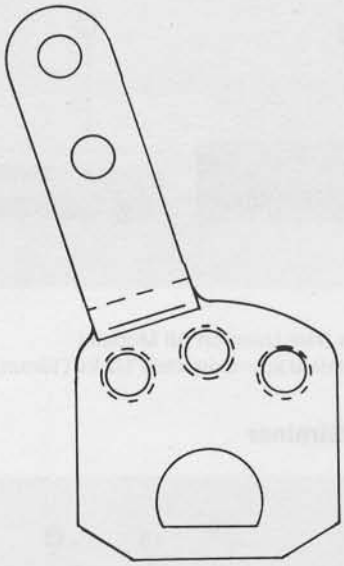
a - Remove Flange Coupling
b - Install Yoke for Drive Shaft

Transmission with Yoke

Transmission Shift Levers

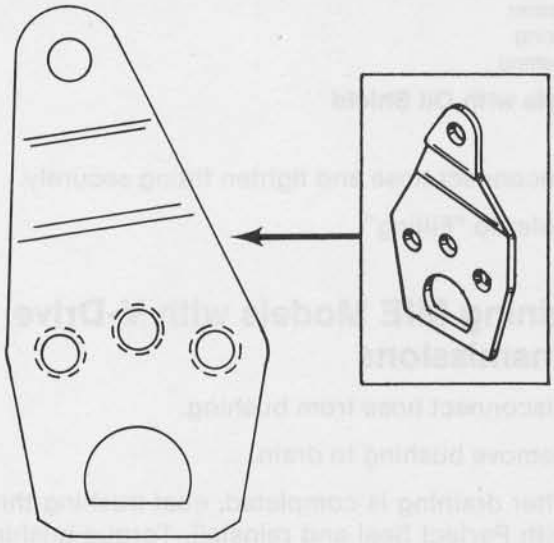
Two different shift levers are used on Borg-Warner transmissions. Refer to illustrations, following for identification.

MIE 230/260/340/5.0 Litre, 5.7 Litre, 5.7 Ski, MCM 330 B-W, MCM 370TRS - S.N. 6721528 and Above



Shift Lever - P.N. 43325

MCM 230TR/260TR, 5.7 Litre TR, 7.4 Litre TR, MCM Production Performance Models Except MCM 370TRS - S.N. 6721528 and Above



Shift Lever - P.N. 12128

Shift Cable Adjustment

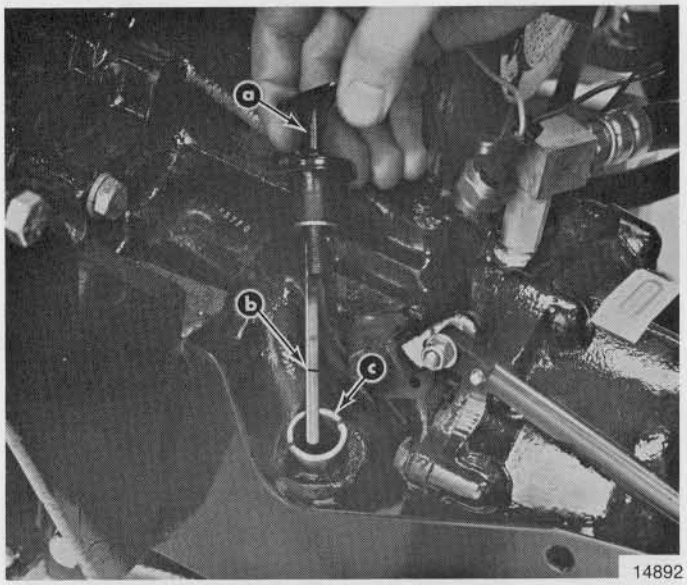
Refer to Section 2 (see appropriate section-part "Index".

Checking Transmission Fluid Level

IMPORTANT: Use only specified automatic transmission fluid. (see "Specifications").

Check transmission fluid before starting engine each day, as follows:

1. Remove dipstick. Check fluid level as indicated on dipstick. Fluid level may be somewhat over full mark, as some of the fluid from transmission fluid cooler and hoses may have drained back into transmission. If low, add automatic transmission fluid (ATF) to bring level up to full mark on dipstick.



a - Dipstick
b - Full Mark
c - Dipstick Tube

IMPORTANT: To accurately check fluid level, engine must be run at 1500 RPM for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for 2 minutes to fill all hydraulic circuits.

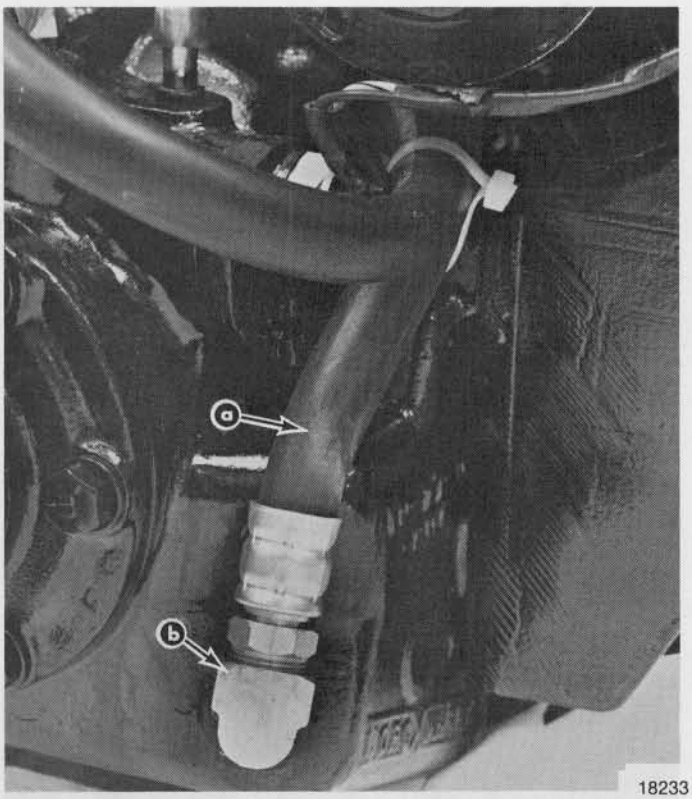
IMPORTANT: Be sure to push dipstick all-the-way down into dipstick tube when checking fluid level.

3. Stop engine and quickly check fluid level. Add automatic transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick.
5. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

Changing Transmission Fluid

Draining MCM and MIE Models with In-Line Transmissions

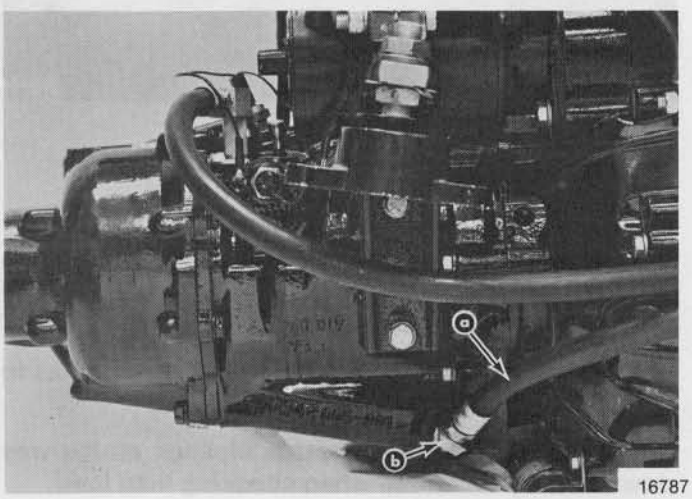
1. Disconnect hose from bushing.



18233

a - Hose
b - Bushing

MIE 10-17 Transmission 1:1 Ratio Only

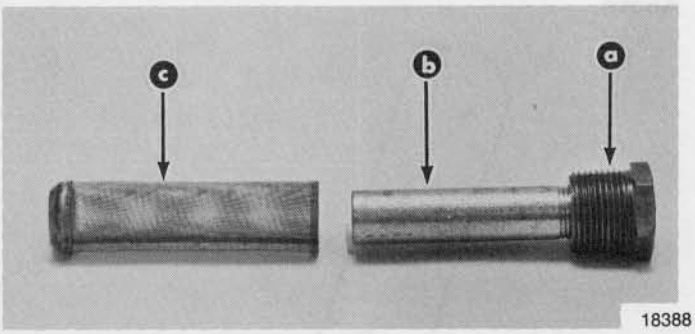


16787

a - Hose
b - Bushing

10-18 Transmission 1:1 Ratio, All Transmissions with Reduction Gear and All MCM Transmissions

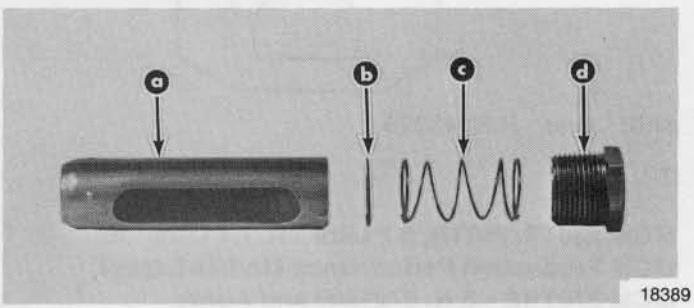
2. a. Remove components shown and allow transmission to drain completely.
   b. Clean strainer (if equipped).
   c. Coat bushing threads with Perfect Seal. Install components in order shown.
   d. Torque bushing to 25 lbs. ft. (34 N.m).



18388

a - Bushing
b - Charge Tube (Not Used on All Models)
c - Strainer [Installed approximately 1/2 In. (13mm) Below Surface of Case]

Models with Strainer



18389

a - Oil Shield (Slot Toward Bottom of Transmission)
b - Washer
c - Spring
d - Bushing

Models with Oil Shield

3. Reconnect hose and tighten fitting securely.
4. Refer to "Filling".

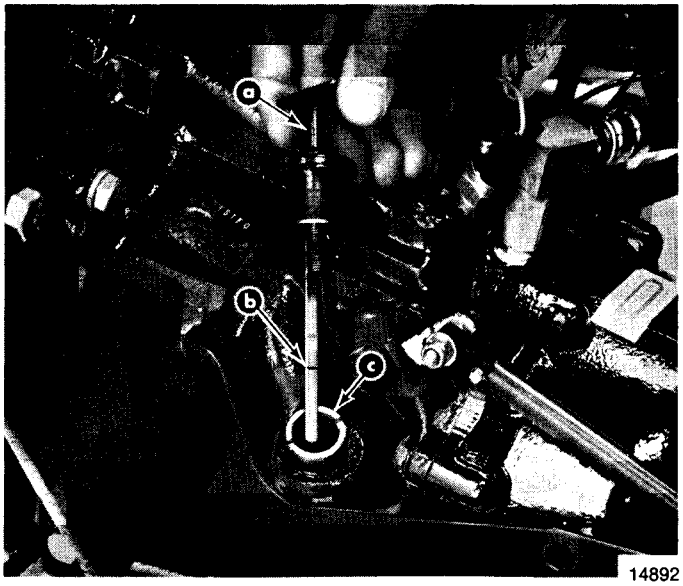
Draining MIE Models with V-Drive Transmissions

1. Disconnect hose from bushing.
2. Remove bushing to drain.
3. After draining is completed, coat bushing threads with Perfect Seal and reinstall. Torque bushing to 25 lbs. ft. (34 N.m).
4. Reconnect hose and tighten fitting securely.
5. Refer to "Filling".

Filling Transmission

IMPORTANT: Use only specified automatic transmission fluid. (see "Specifications")

1. Remove dipstick. Fill transmission with fluid, thru dipstick hole, to bring up to full mark.



14892

a - Dipstick
b - Full Mark
c - Dipstick Tube

IMPORTANT: To accurately check fluid level, engine must be run at 1500 RPM for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for 2 minutes to fill all hydraulic circuits.

NOTE: Be sure to push dipstick all-the-way down into dipstick tube when checking fluid level.

3. Stop engine and quickly check fluid level. Add automatic transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick. Be sure to tighten "T" handle securely.

Removal and Installation

Inboard and V-Drive

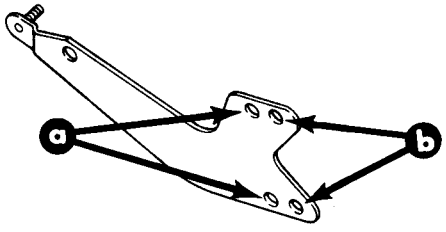
NOTICE
The following procedure describes removal of transmission without removing engine. If engine must be removed, refer to Section 2, (see "Index").

1. Drain transmission fluid.
2. Disconnect fluid cooler hoses.
3. Disconnect shift cable.
4. Disconnect wires from neutral start safety switch.
5. **Models With Audio Warning System:** Disconnect wire from fluid temperature switch.
6. Disconnect propeller shaft coupling.
7. Remove 4 rear mount (to engine bed) bolts.
8. Support rear part of engine with either a hoist or by using wooden blocks under flywheel housing.
9. Remove 2 center transmission to flywheel housing attaching bolts and install 2 long studs.

IMPORTANT: These 2 long studs will help support weight of transmission during removal and installation.

10. Remove remaining transmission attaching bolts.
11. Pull transmission straight back and off engine.
12. Before installing transmission, check transmission pump indexing for correct rotation. Refer to "Pump Indexing".
13. **In-Line Transmissions Only:** Check transmission output shaft rolling torque. See "Specifications".
14. Apply 2-4-C Marine Lubricant to transmission input shaft splines and engine drive plate splines.
15. If removed, install rear engine mounting brackets (to transmission) as outlined in "Section 6, "Engines" (see"Index"). Torque to 45 lbs. ft. (61 N.m).

IMPORTANT: MIE 230/260/5.7 Ski/340 Only: If transmission has shift cable anchor plate 93141A7, refer to illustration following.



a - Use These Mounting Holes on MIE 230/260/5.7 Ski
b - Use These Mounting Holes on MIE 340

93141A7 Plate

16. Align transmission splines with drive plate splines.
17. Slide transmission into place and secure with bolts.
18. Remove 2 long studs (installed in step 9) and install remaining 2 bolts. Torque all bolts to 50 lbs. ft. (68 N.m)
19. Relieve hoist tension and fasten rear engine mounts to engine bed. Tighten bolts securely.
20. Connect wires to neutral start safety switch.
21. **Models With Audio Warning System:** Connect tan/blue wire to fluid temperature switch.
22. Connect fluid cooler hoses to transmission.
23. Refill transmission with specified fluid.

24. Refer to Section 2, (see "Index") for the following:
    - Alignment.
    - Shift cable attachment and adjustment.
25. Check for leaks and fluid level after first engine start up.

Stern Drive Models (Transom Mounted Engines)

1. Remove engine. Refer to Section 2 (see "Index").
2. Drain transmission fluid.
3. Disconnect fluid cooler hoses.
4. Disconnect wires from neutral start safety switch.
5. **Models With Audio Warning System:** Disconnect wire from fluid temperature switch.
6. Remove 2 center transmission to flywheel housing attaching bolts and install 2 long studs.

IMPORTANT: These 2 long studs will help support weight off transmission during removal and installation.

7. Remove remaining transmission attaching bolts.
8. Pull transmission straight back and off engine.
9. Before installing transmission, check transmission pump indexing for correct rotation. Refer to "Pump Indexing" (See "Index").
10. If removed, install transmission side brackets. Torque bolts to specifications.
11. Apply 2-4-C Marine Lubricant to transmission input shaft splines and engine drive plate splines.
12. Align transmission splines with drive plate splines.
13. Slide transmission into place and secure with bolts.
14. Remove 2 long studs (installed in step 6) and install remaining 2 bolts. Torque all bolts to specifications.
15. Connect wires to neutral start safety switch.
16 **Models With Audio Warning System:** Connect tan/blue wire to fluid temperature switch.
17. Connect fluid cooler hoses to transmission.
18. Reinstall engine. Refer to Section 2 (see "Index").
19. Refill transmission with specified fluid.
20. Align engine and transmission. Refer to Section 2 (see "Index").
21. Attach and adjust shift cable. Refer to Section 2 (see "Index").
22. Check for leaks and fluid level after first engine start-up.

Production Performance Stern Drive Models (Forward Mounted Engines)

1. Drain transmission fluid.
2. Disconnect fluid cooler hoses.
3. Disconnect shift cable.
4. Disconnect wire from neutral start safety switch.

⚠CAUTION

Drive shaft has been assembled and balanced at the factory with the universal joint yokes (on both ends of shaft) running in the same plane. Refer to Section 2, Part D (see "Index") before proceeding.

5. Disconnect drive shaft from transmission. Refer to Section 2, Part D (see "Index").
6. Remove 2 center transmission to flywheel housing attaching bolts and install 2 long studs.

IMPORTANT: These 2 long studs will help support weight of transmission during removal and installation.

7. Remove remaining transmission attaching bolts.
8. Pull transmission straight back and off engine.
9. Before installing transmission, correct transmission pump indexing, for correct rotation. Refer to "Pump Indexing" (see "Index").
10. Apply 2-4-C Marine Lubricant to transmission input shaft splines and engine drive plate splines.
11. Align transmission splines with drive plate splines.
12. Slide transmission into place and secure with bolts.
13. Remove 2 long studs (installed in step 6) and install remaining 2 bolts. Torque all bolts to 50 lbs. ft. (68 N.m).
14. Connect wires to neutral start safety switch.
15. Connect fluid cooler hoses to transmission.
16. Reconnect drive shaft to transmission. Refer to Section 2, Part D (see "Index").
17. Refill transmission with specified fluid.
18. Align engine and transmission. Refer to Section 2, Part D (see "Index").
19. Attach and adjust shift cable. Refer to Section 2, Part D (see "Index").
20. Check for leaks and fluid level after first engine start-up.

Pump Indexing

Pump must be correctly indexed to correspond with engine rotation. If pump is not indexed correctly, pump will not create oil pressure and transmission will not shift. Pump housing has two arrows, each pointing in a different direction. Pump must be positioned so that the arrow (pointing in the direction that input shaft and pump will be turned by engine) is at the top of transmission.

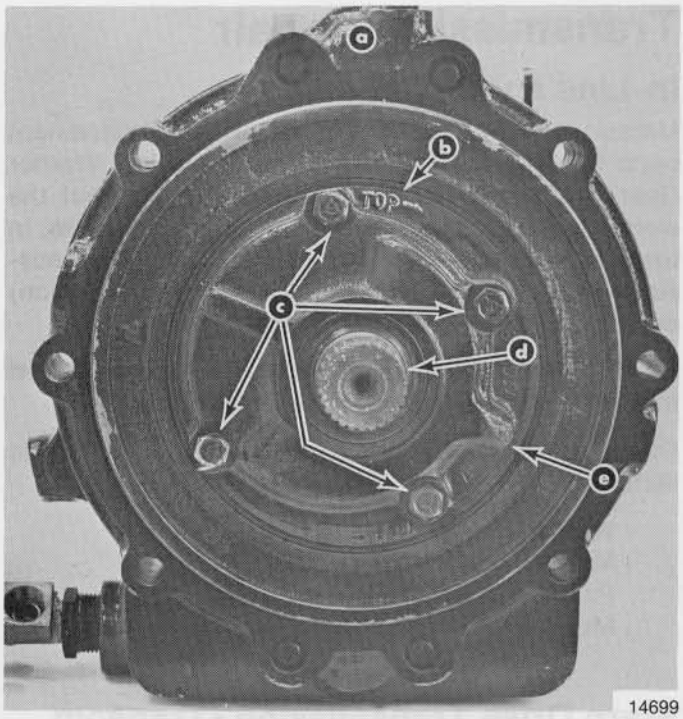
IMPORTANT: Some transmissions have letters "R.H." and "L.H." on pump housing. Letters Do not indicate engine rotation.

If pump must be reindexed, proceed as follows:

1. Remove 4 pump attaching bolts.
2. Loosen the pump housing. A soft tip mallet may be used to tap the fluid passage boss. Do not strike the bolt bosses.

IMPORTANT: Do not remove the pump from the shaft unless a seal protector is used to prevent the shaft splines from cutting the pump seal. Care must be taken to ensure that seal, gasket, seal and bolt bosses are kept in good condition to prevent leaks in those critical areas.

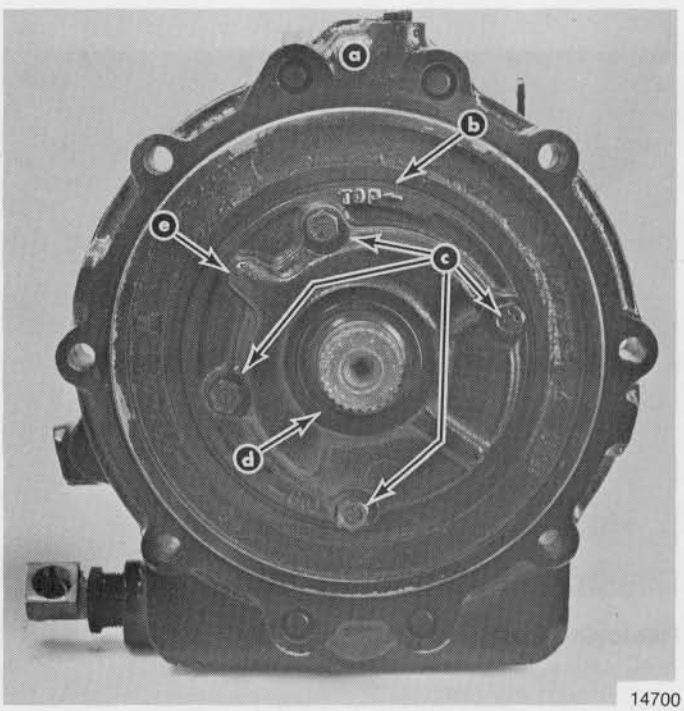
3. Make sure that pump gasket is not sticking to housing (to prevent gasket from tearing or folding) when rotating pump.
4. Rotate pump until arrow indicating the proper direction of pump rotation is near the top of transmission.
5. Reinstall 4 pump to adaptor attaching bolts and torque to 204-264 lbs. in. (23-29 N.m).



14699

a - Top of Transmission
b - Top ⟶ (or Top R.H.)
c - Pump Attaching Bolts
d - Input Shaft
e - Fluid Passage Boss

MCM and MIE L.H. (Standard) Rotation Engines



14700

a - Top of Transmission
b - Top ⟵ (or Top L.H.)
c - Pump Attaching Bolts
d - Input Shaft
e - Fluid Passage Boss

MIE R.H. (Opposite) Rotation Engines

Transmission Repair

In-Line and V-Drive

Mercury Marine does not stock or sell replacement parts for the in-line or V-drive transmission. Warner Gear has a network of distributors throughout the world to service their product. These distributors, in turn, have a dealer network to service the transmissions. Also, service manuals (for each transmission) can be obtained from Warner Gear.

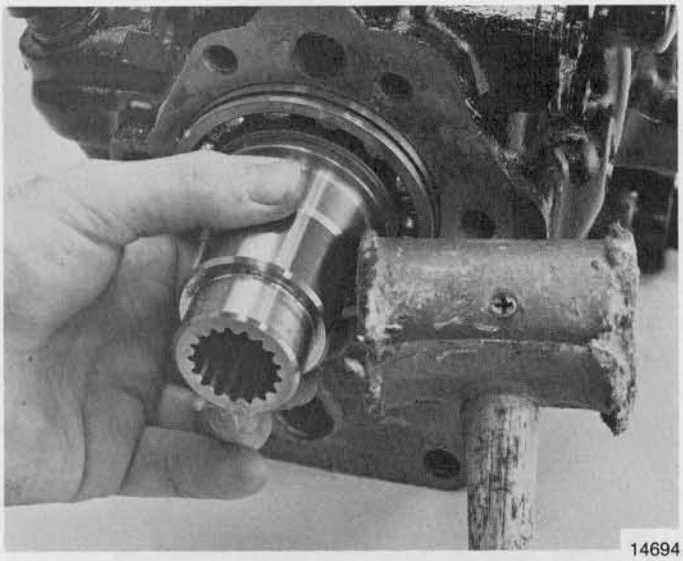
IMPORTANT: Refer to "Special Replacement Part Information" before working on transmission.

For the location of your closest distributor or service literature contact:

Warner Gear
Marketing Communications
P.O. Box 2688
Muncie, IN 47302 USA

Stern Drive Transmission (Transom Mounted Engine) Coupling Replacement

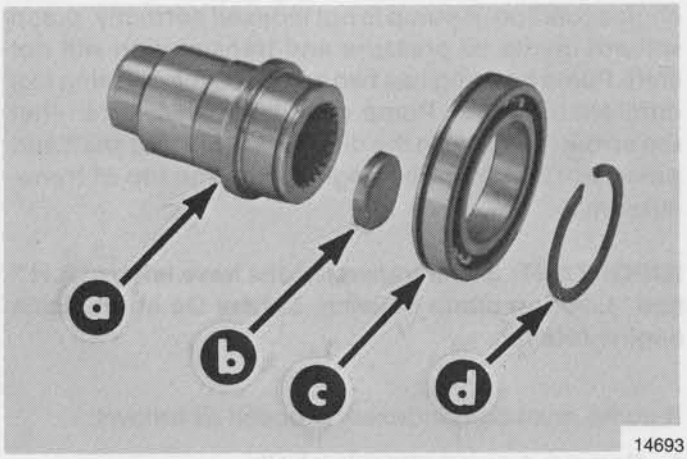
1. Remove tailstock assembly as outlined following (see "Index").
2. Tap coupling assembly with a soft-tip mallet while pulling to remove.



14694

Removing Coupling Assembly

3. Remove snap ring from coupling and press coupling from ball bearing.



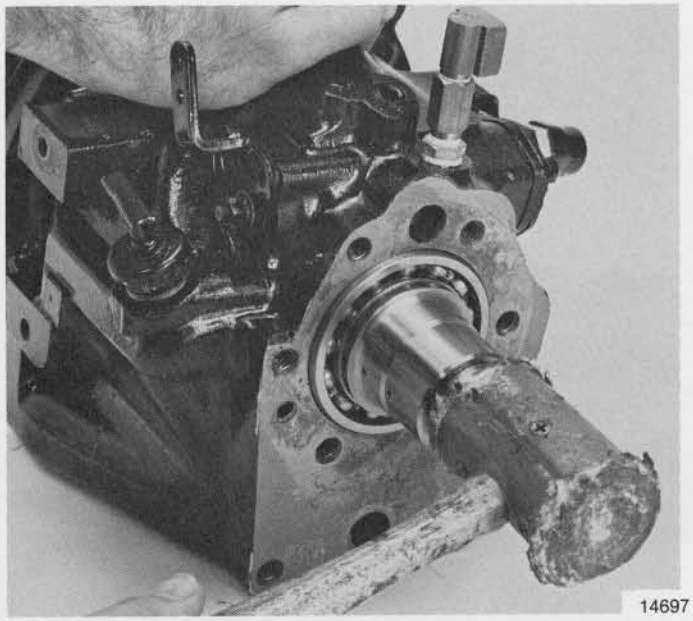
14693

a - Coupling
b - Expansion Plug
c - Ball Bearing
d - Snap Ring

4. Drive expansion plug out transmission end of coupling.
5. Inspect and clean all parts. Replace any worn parts.
6. Apply a thin coat of Loctite "A" to outer diameter of new expansion plug. Press plug into coupling (with cupped side away from transmission) until it bottoms out.
7. Pressing on inner race only, press ball bearing onto coupling (with numbered side up) until it bottoms out. Install snap ring.

IMPORTANT: Some bearings may have a groove completely around the outer race. Install this type bearing with the groove away from transmission.

8. Install coupling assembly on output shaft splines and tap into place using a soft tip mallet.



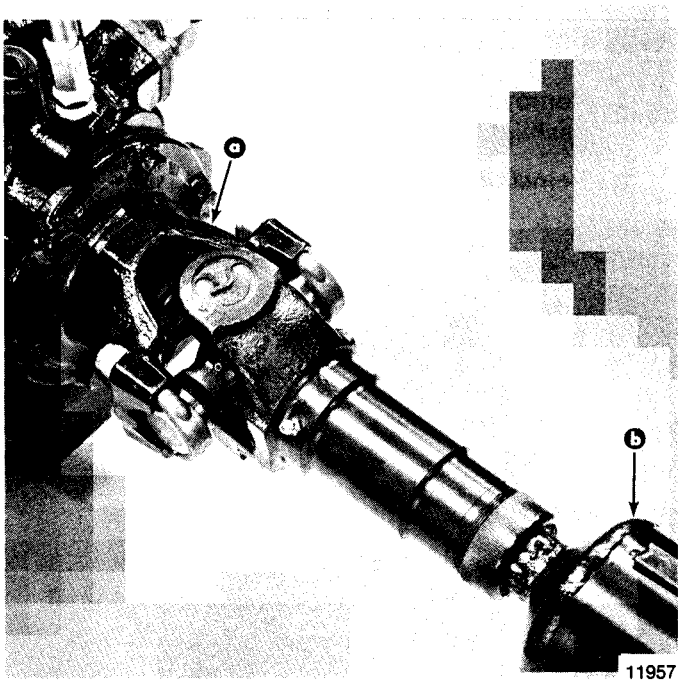
14697

Installing Coupling Assembly

Stern Drive Transmission (Forward Mounted Engine) Yoke Replacement

Drive shaft has been assembled and balanced at the factory with the universal joint yokes (on both ends of shaft) running in the same plane. Refer to "Section 2, Part D" Before procceding.

1. Drain transmission.
2. Hold yoke and remove nut.
3. Using a puller, remove yoke from transmission output shaft.
4. Inspect transmission seal.
5. After lubricating lip of seal, align splines in yoke with splines on output shaft.
6. Gently press yoke onto shaft, until contact with inner race of bearing (in transmission) is made.
7. Install nut and torque to 100-200 lbs. ft. (136-271 N.m).
8. Reconnect drive shaft as outlined in "Section 8, Part B".
9. Refill transmission.
10. Check for leaks and fluid level after first start up of engine.



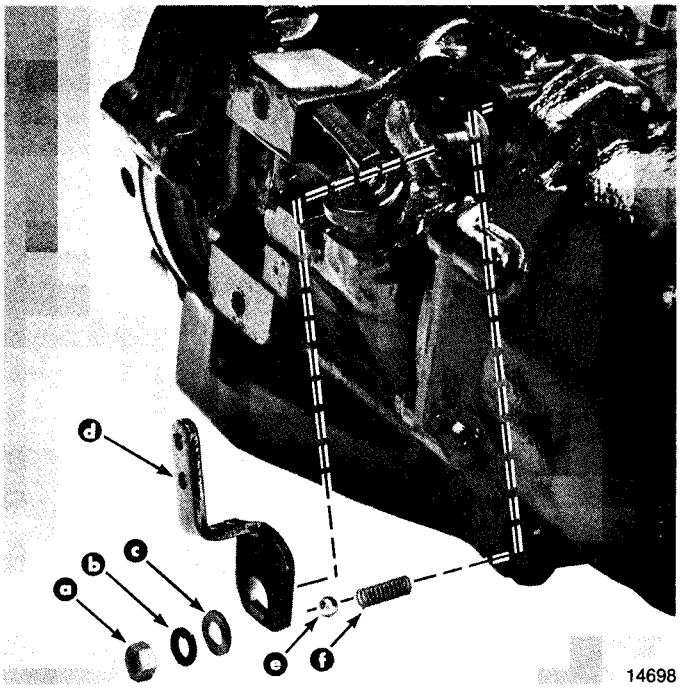
a - Transmission Yoke
b - Drive Shaft

Shift Lever Installation

IMPORTANT: Warner Gear warranty is jeopardized if the shift lever poppet spring and/or ball is permanently removed, or if the shift lever is changed in any manner, or repositioned, or if the linkage between the remote control and the transmission shift lever does not have sufficient travel in both directions.

Shift lever and related parts must be assembled as shown.

1. Lubricate poppet ball, spring, and holes in shift lever with 2-4-C Marine Lubricant.
2. Torque nut to 96-132 lbs. in. (11-15 N.m).



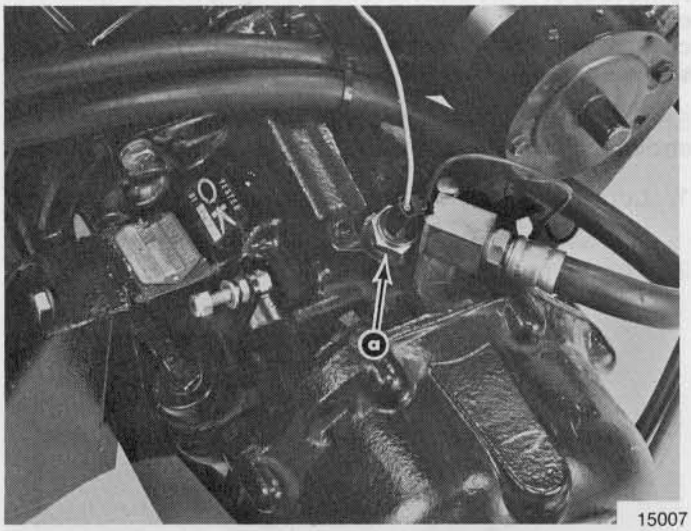
a - Nut
b - Lockwasher
c - Flat Washer
d - Shift Lever
e - Poppet Ball
f - Poppet Spring

Typical Shift Lever

3. After installation, move shift lever thru forward, neutral and reverse positions. No more than finger tip effort should be required. If valve binds, cause for binding must be found and corrected.

Pressure Test

1. Install pressure gauge.



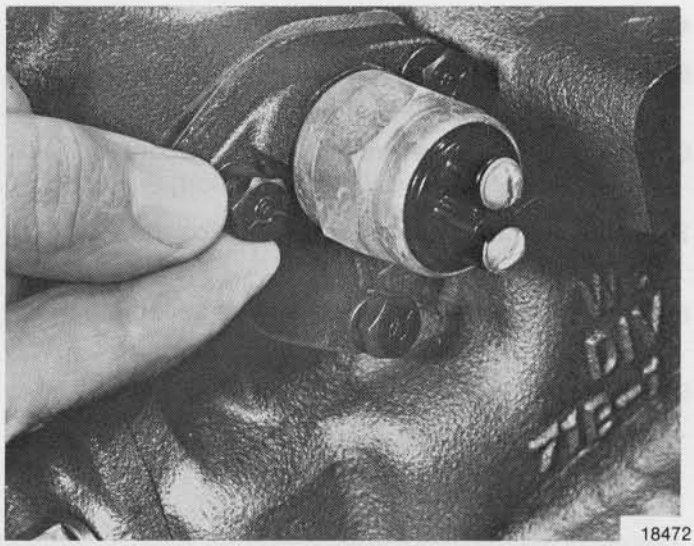
a - Main Line Pressure Tap - Models with Audio Warning System, Remove Temperature Switch; Models without Switch, Remove 3/8 In. Pipe Plug

2. With boat in water, start engine and run until normal operating temperature is reached.
3. Refer to "Specifications" (see "Index") for pressure readings.

Pressure Regulator Valve Spring Identification

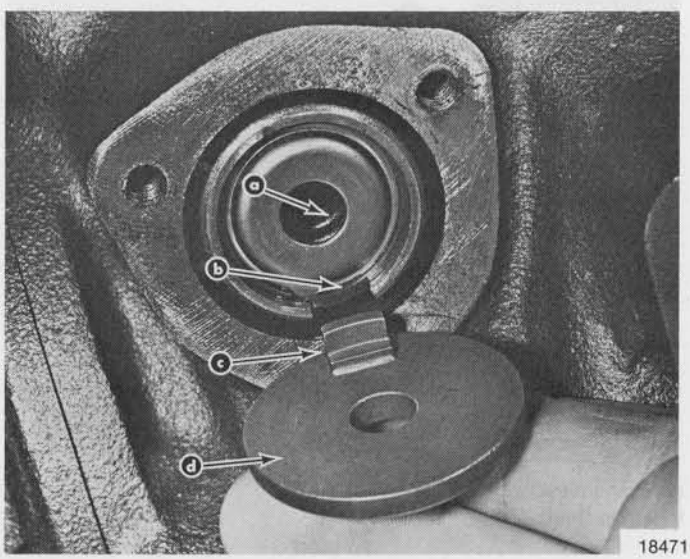
Two different pressure regulator valve springs have been used in Warner Gear transmissions. The black spring (P.N. 71-242) was used in earlier transmisssions, while the white spring (P.N. 72N-242) is used in later production transmissions. Refer to "Identification" (see "Index") for starting serial numbers of transmissions that use the white spring. Visual inspection can be used to determine color of spring.

1. Remove neutral start safety switch.



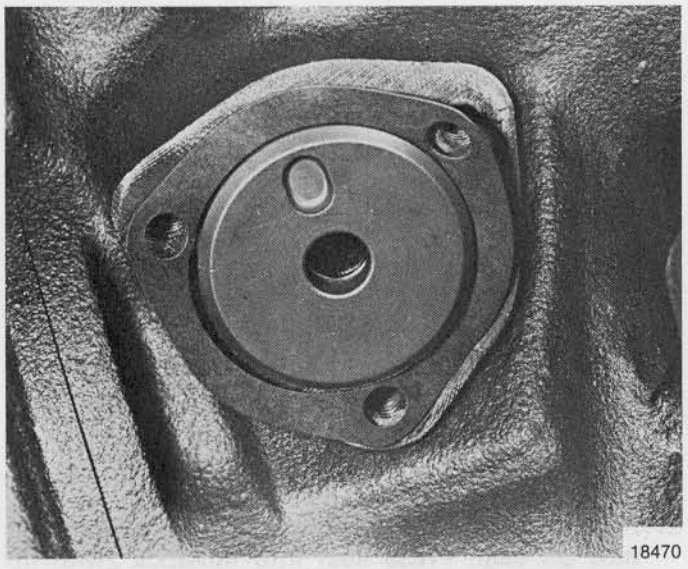
Neutral Start Safety Switch

2. a. Remove switch cam; then, look thru hole (with flashlight) to determine color of spring.
   b. Reinstall switch cam. Make sure tang is in slot.



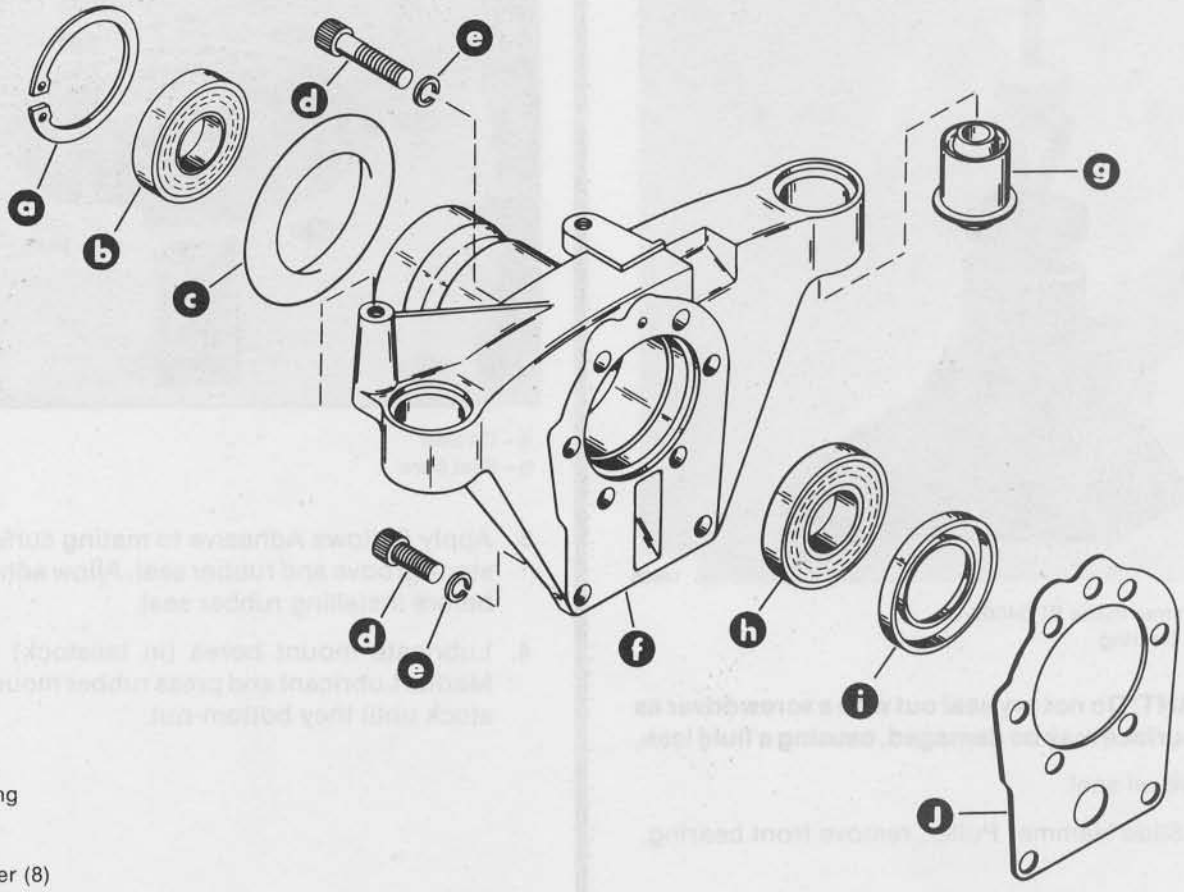
a - Spring
b - Slot
c - Tang
d - Switch Cam

3. Before installing neutral start safety switch, be sure switch cam is positioned as shown; then, install switch. Torque bolts to 8-11 lbs. ft. (11-14 N.m).



Correct Switch Cam Position

Tailstock Assembly Repair



a - Snap Ring
b - Ball Bearing
c - Seal
d - Screw (8)
e - Lockwasher (8)
f - Tailstock Assembly
g - Rubber Mount (2)
h - Ball Bearing
i - Oil Seal
j - Gasket

Removal/Installation

1. Remove tailstock to transmission attaching screws and remove tailstock. Discard gasket.
2. After repairs, apply Loctite A to threads of tailstock attaching screws. Apply RTV Sealer to both sides of new gasket.
3. Install gasket and tailstock on transmission with screws. Hex head screws are installed in 2 lower mounting holes.
4. Torque screws to 50 lbs. ft. (68 N.m).

Disassembly

1. Remove rubber seal from aft end of tailstock.

IMPORTANT: Bearings, oil seal, and rubber mounts must be replaced, if removed.

2. Press rubber mounts out of tailstock.
3. Remove snap ring; then, remove rear ball bearing using Slide Hammer Puller.

14695

a - Slide Hammer Puller 91-34569A1
b - Rear Ball Bearing

IMPORTANT: Do not pry seal out with a screwdriver as tailstock surface may be damaged, causing a fluid leak.

4. Remove oil seal.
5. Using Slide Hammer Puller, remove front bearing.

Cleaning and Inspection

IMPORTANT: Do not clean tailstock assembly in solvent as sealed ball bearings and rubber components may be damaged.

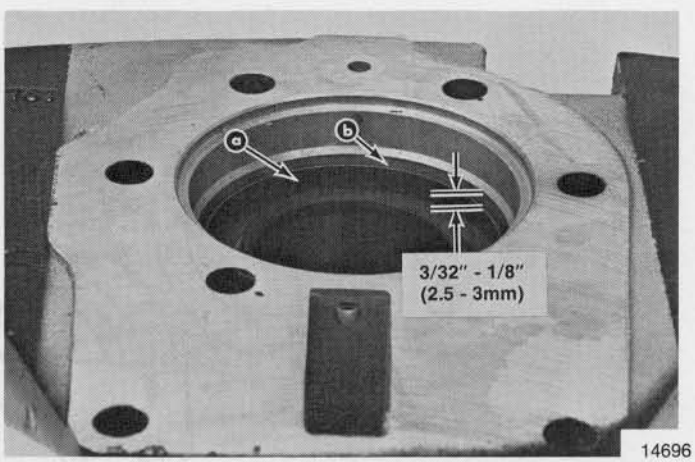
1. Clean tailstock assembly.
2. Inspect rubber seal and rubber mounts.
3. Inspect ball bearings.
4. Inspect oil seal.

Reassembly

1. Lubricate bearing bore (in tailstock) with 2-4-C Marine Lubricant. Press front and rear bearings into tailstock (with numbered side out) until they bottom out. Install snap ring.

IMPORTANT: Do not press on inner race.

2. Apply a thin coat of Loctite A to outer diameter of new oil seal. Press seal into tailstock (with lip toward transmission) until it is 3/32 in. - 1/8 in. (2.5 - 3mm) below tailstock mounting surface. Seal must be square in seal bore.



14696

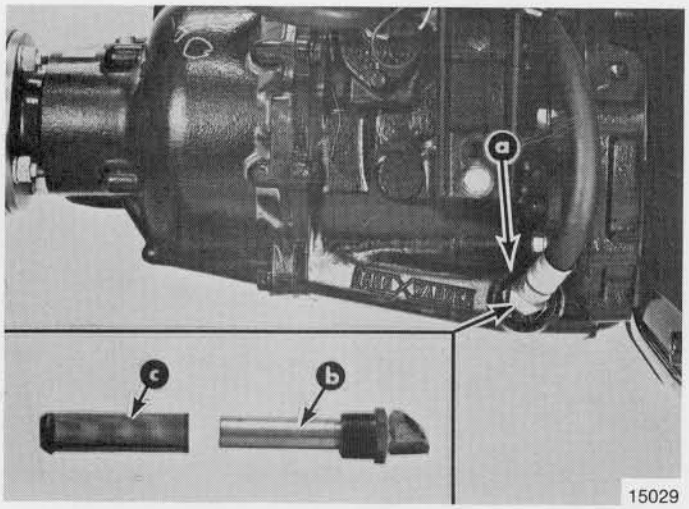
a - Oil Seal
b - Seal Bore

3. Apply Bellows Adhesive to mating surfaces of tailstock groove and rubber seal. Allow adhesive to dry before installing rubber seal.
4. Lubricate mount bores (in tailstock) with 2-4-C Marine Lubricant and press rubber mounts into tailstock until they bottom-out.

Transmission Venting

Certain operating conditions, such as, but not limited to, constant high RPM operation or high engine angle (while underway), can cause the transmission to vent fluid out of the vent tube. To help correct this condition, determine the model and gear ratio of the transmission that is having the venting problem.

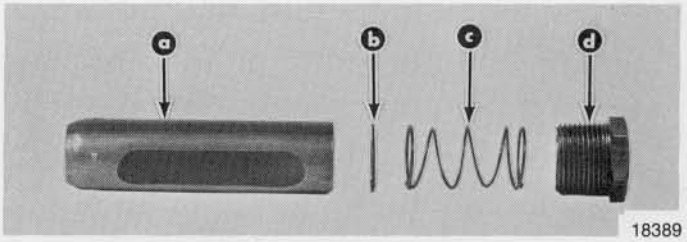
1. Remove hose; then, remove bushing from transmission.
2. Remove charge tube and strainer and discard.



a - Hose and Bushing
b - Unscrew Charge Tube — Discard
c - Strainer — Discard

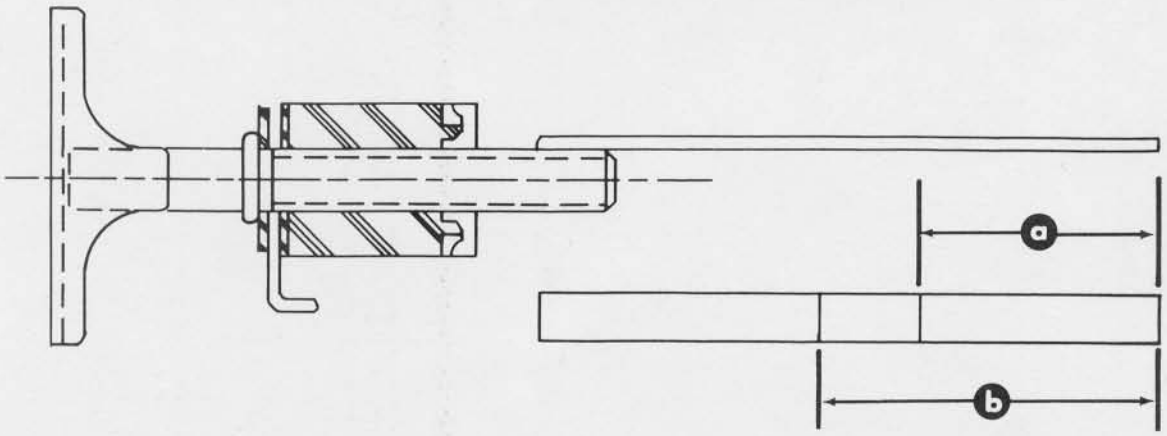
IMPORTANT: Oil shield, washer and spring are Warner Gear Parts. Order from their dealers.

3. Install oil shield, washer and spring.



a - 72C-98 Oil Shield - Slot Toward Bottom of Transmission
b - 35-143 Washer
c - 5L-222 Spring
d - Bushing

4. Coat threads of bushing with Perfect Seal and install into transmission. Torque to specifications.
5. Reconnect hose and tighten fitting securely.
6. Lower fluid level in transmission by remarking dipstick as shown.
7. Refill transmission as outlined under "Changing Fluid" (see "Index").

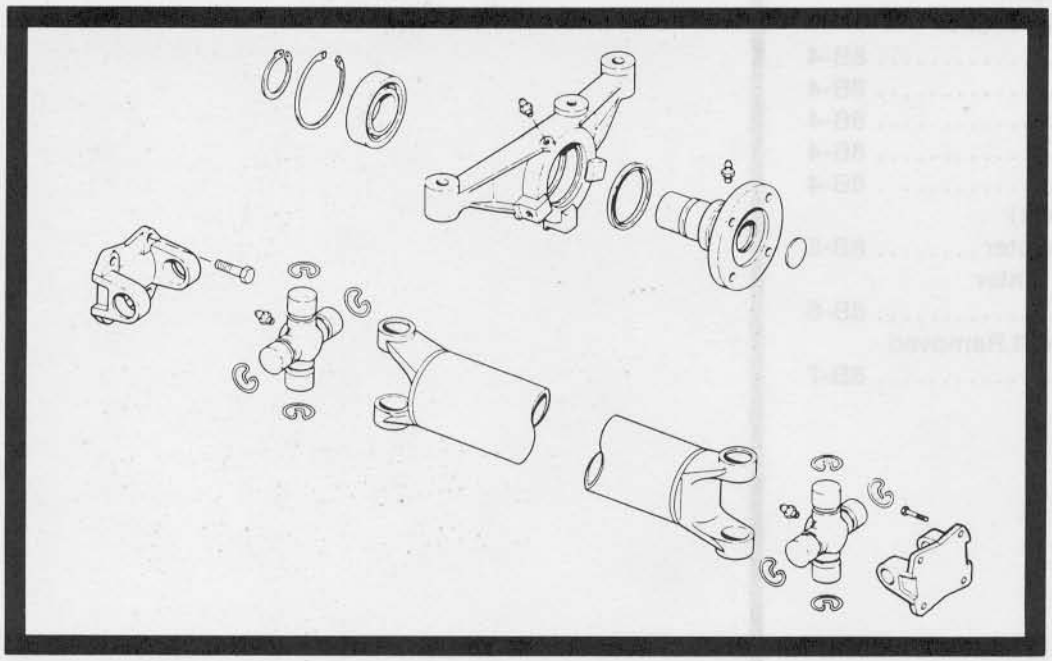


a - 10-17 (1:1 Only) - 1-1/8 In. (29mm) New Full Mark
10-17 (1.5:1 - 3.0:1 Only) — 1-1/4 In. (32mm) New Full Mark
10-18 (All Ratios) — 1-1/4 In. (32mm) New Full Mark
b - Old Full Mark - 1-3/4 In. (44mm) From End

DRIVE SYSTEM

8

B



DRIVE SHAFT MODELS/PROPELLER SHAFT

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Torque Specifications

Fastener Location	Lbs. Ft. (N.m)
Driveshaft to Tailstock Flange (Production Performance Models)	50 (68) (Note 1)
Driveshaft to Transmission Output Flange (Production Performance Models)	35 (48)
Driveshaft to Bearing Support Flange (MCM 200/230/260)	50 (68)
Driveshaft to Output Shaft (MCM 200/230/260)	50 (68)
Output Housing to Tailstock Housing (Production Performance Models)	18 (24)
Flywheel Housing to Block (MCM 200/230/260)	30 (41)
Engine Coupling	35 (48)
Output Shaft Housing to Flywheel Housing (MCM 200/230/260)	30 (41)
Propeller Shaft Coupling to Transmission Coupling (MIE Models)	50 (68)

NOTE 1: Secure with safety wire.

Tools/Lubricants/Sealants

TOOLS/LUBRICANTS/SEALANTS	
91-34569A1	Slide Hammer Puller
92-86154A1	Quicksilver 2-4-C Marine Lubricant
92-32609--1	Quicksilver Loctite A

OBTAIN LOCALLY
Loctite 290

Flywheel Housing/Output Shaft Housing Repair (MCM 305/350 CID)

NOTICE

The following repair procedure requires removal of the drive shaft. In most cases, because of engine compartment space limitations, the engine also must be removed.

Removal and Installation

1. Remove driveshaft, as outlined in "Section 2, Part B".
2. If engine must be removed, refer to "Section 2, Part B.

Disassembly

IMPORTANT: This disassembly procedure, beginning with Step 1, assumes that engine does not require removal from boat. If, however, engine removal is required, refer to "Section 2, Part B" for removal instructions. With engine removed from boat, proceed with disassembly, beginning with Step 3.

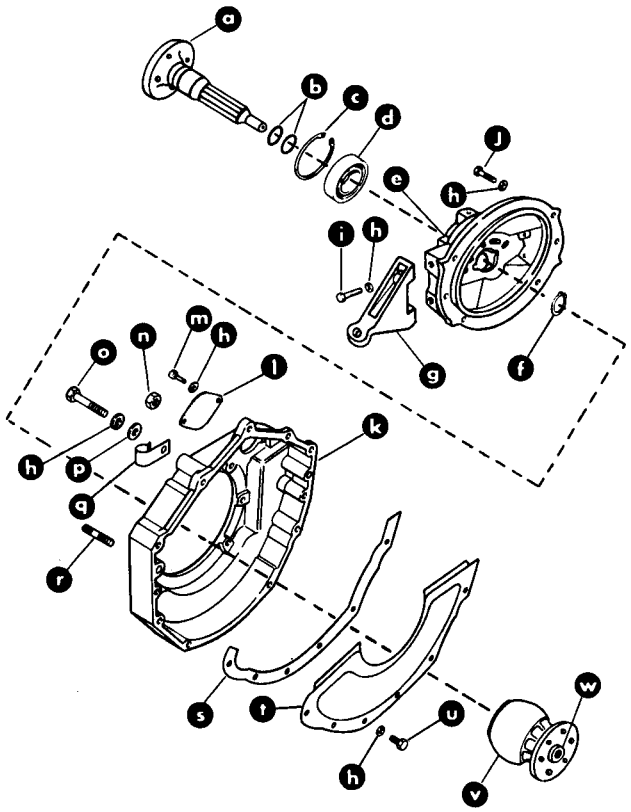
1. Support rear of engine with overhead hoist or wooden blocks under the rear of the engine.
2. Remove stringer bolts (rear engine mounts).
3. Remove output shaft housing attaching screws; then, remove housing.
4. Remove snap ring; then, pull output shaft out of housing.
5. Remove snap ring from housing.
6. Using Slide Hammer Puller, remove bearing from housing.
7. Remove flywheel cover.
8. Remove flywheel housing.
9. Remove engine coupling.
10. Clean and inspect all parts. Replace any damaged parts.

Reassembly

1. Install engine coupling. Torque to 35 lbs. ft. (48 N.m).
2. Install flywheel housing. Torque to 18 lbs. ft. (24 N.m).
3. Using new gasket, install flywheel cover. Tighten screws securely.

IMPORTANT: Groove in outside diameter of ball bearing must align with grease fitting hole.

4. Install ball bearing into output shaft housing; then, install snap ring.
5. Apply 2-4-C Marine Lubricant to "O" rings (on output shaft), then slide shaft thru bearing. Secure shaft with snap ring.
6. Apply 2-4-C Marine Lubricant to splines on output shaft.
7. Install output shaft housing to flywheel housing. Torque screws to 30 lbs. ft. (48 N.m).
8. Secure rear engine mounts to stringer with bolts. Tighten securely.
9. Remove hoist (or wooden blocks).
10. Install drive shaft and check alignment.
11. Using 2-4-C Marine Lubricant, grease ball bearing thru grease fitting.



a - Output Shaft
b - "O" Rings
c - Snap Ring - Ball Bearing
d - Ball Bearing
e - Shaft Housing
f - Snap Ring - Output Shaft
g - Rear Engine Mount (2)
h - Lockwasher
i - Screw (4)
j - Screw (6)
k - Flywheel Housing
l - Plate
m - Screw (2)
n - Nut (1)
o - Screw (4)
p - Washer (1)
q - Clamp (1)
r - Stud (1)
s - Gasket
t - Cover - Flywheel
u - Screw (7)
v - Coupling - Engine
w - Bushing

Flywheel Housing/Output Shaft Housing

Drive Shaft Repair (MCM 305/350 CID)

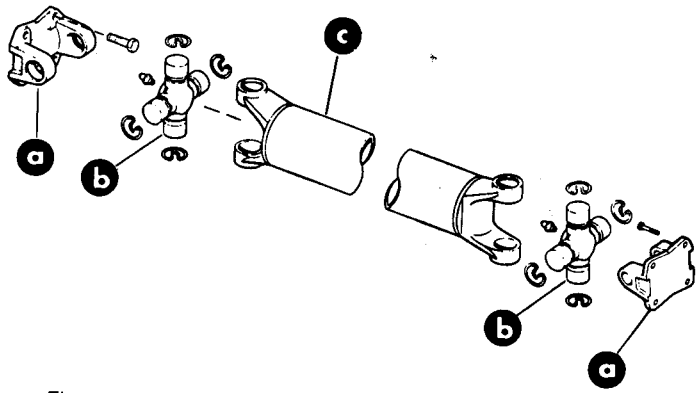
Removal and Installation

Remove driveshaft as outlined in "Section 2, Part B".

Repair

⚠CAUTION
Be sure U-joint locking rings are seated properly after replacing U-joints.

1. Replace U-joints, if required.
2. Replace flange, if required.

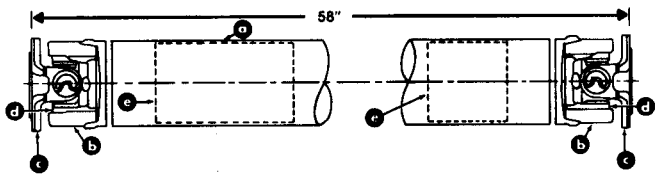


a - Flange
b - U-Joint
c - Drive Shaft

Drive Shaft

Replacement Drive Shafts

Currently, MerCruiser is furnishing a standard 58 in. (147.3cm) long drive shaft with all Extension Shaft Models listed above. Some boat manufacturers modify the drive shafts to a shorter length. Because of this, use the following procedure to obtain replacement drive shafts.



a - Tube
b - Yoke - Tube
c - Flange
d - Universal Joint
e - Sound Deadener (Cardboard Tube)

Extension Drive Shaft

58 In. (147.3cm) Long (Standard Length) Drive Shaft:

The complete drive shaft can be ordered from Mercury Marine.

Drive Shafts Modified to Shorter Lengths:

The complete modified (shortened) drive shaft has to be ordered from the boat manufacturer that installed the MerCruiser Power Package.

IMPORTANT: Dana Corporation - Spicer Regional Drive Shaft Centers will not shorten replacement drive shafts for dealers or consumers.

If a boat manufacturer is currently having Extension Drive Shafts modified, they must be modified by one of Dana Corporation - Spicer Regional Drive Shaft Centers to maintain Mercury Marine warranty. The modified drive shaft must meet the following specifications.

- **U-joints aligned radially within 0° (±1/2°).**
- **U-joints greased after welding with Quicksilver 2-4-C Marine Lubricant.**
- **Assembly balanced with within 1.5 oz. in. to 4500 RPM.**
- **Tube to have .005 in. (.127mm) - .010 in. (.254mm) interference fit with tube yoke.**
- **Tube must be straight and round within .015 in. (.381mm)**

Bearing Support Repair (MCM 305/350 CID)

Removal and Installation

Refer to "Section 2, Part B".

Disassembly

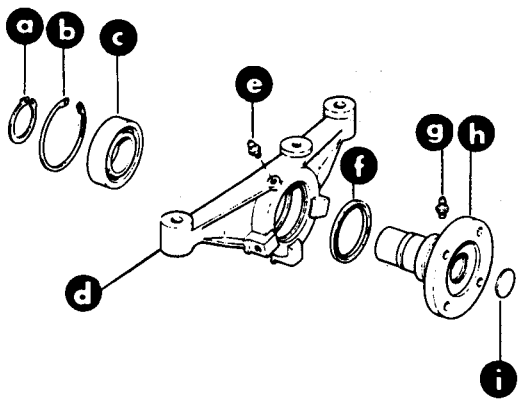
1. Remove snap ring; then, remove input shaft.
2. Remove larger snap ring.
3. Using Slide Hammer Puller, remove ball bearing.
4. Remove oil seal.
5. If required, remove plug from end of input shaft.
6. Clean and inspect all parts.
7. Replace any damaged parts.

Reassembly

1. If removed, install new plug in end of input shaft.
2. Apply Loctite A to outer diameter of new oil seal.
3. Press oil seal into bearing support. Lip of seal faces away from ball bearing.
4. Apply Loctite 290 to outer diameter of ball bearing and inner diameter of bearing support.
5. Install bearing (with sealed side toward snap ring) by using a press. After installation, wipe up excessive Loctite. Install snap ring.
6. Apply Loctite 290 to outer diameter of input shaft (bearing area) and inside diameter of bearing race.
7. Install input shaft; then, install snap ring. Wipe up excessive Loctite.

IMPORTANT: Do not let Loctite get into ball bearing.

8. Fill bearing area with 2-4-C Marine Lubricant thru grease fitting.
9. Apply 2-4-C Marine Lubricant to splines of input shaft before installing drive unit.



a - Snap Ring - Input Shaft
b - Snap Ring - Ball Bearing
c - Ball Bearing
d - Bearing Support
e - Grease Fitting
f - Oil Seal
g - Grease Fitting
h - Input Shaft
i - Plug - Input Shaft

Bearing Support Assembly

Tailstock Assembly/Drive Shaft Repair (Production Performance Models, Front Mounted Engine)

Removal and Installation

Refer to "Section 2, Part D".

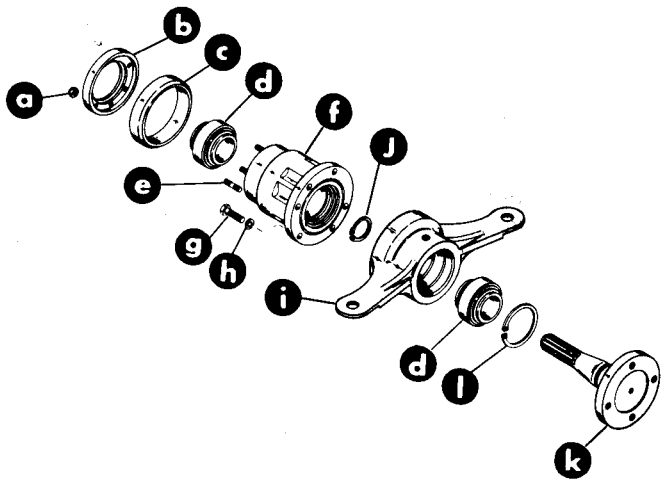
Tailstock Disassembly

1. Remove nuts, retainer and rubber mount from output housing; then, remove ball bearing.
2. Remove screws and separate output housing from tailstock housing.
3. Remove tailstock shaft snap ring; then, slide shaft out of tailstock housing.
4. Remove snap ring from tailstock. Remove ball bearing.
5. Clean and inspect all parts. Replace any damaged parts.

Tailstock Reassembly

IMPORTANT: Groove in outside diameter of ball bearings must align with grease fitting holes.

1. Install ball bearing into tailstock housing; then, install snap ring.
2. Apply 2-4-C Marine Lubricant to splines of tailstock shaft.
3. Slide shaft thru bearing. Secure bearing with snap ring.
4. Apply Loctite A to threads of output housing attaching screws.
5. Assemble output housing to tailstock housing. Torque screws to 18 lbs. ft. (24 N.m).
6. Install ball bearing.
7. Apply Loctite A to output housing studs.
8. Install rubber mount, retainer and nuts.
9. Grease both bearings with 2-4-C Marine Lubricant.



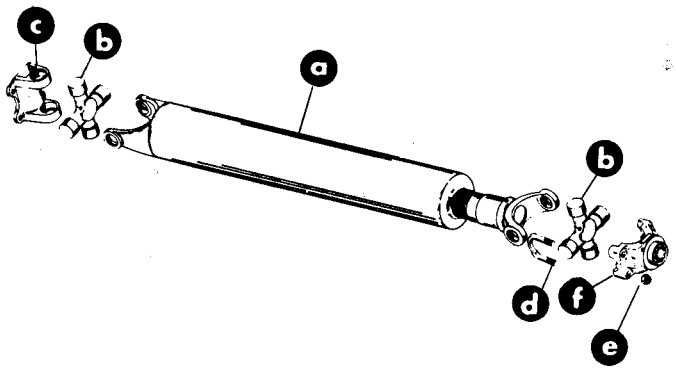
a - Nut (6)
b - Retainer
c - Rubber Mount
d - Ball Bearing (2)
e - Stud (6)
f - Output Housing
g - Screw (6)
h - Lockwasher (6)
i - Tailstock Housing
j - Snap Ring - Tailstock Shaft
k - Tailstock Shaft
l - Snap Ring - Tailstock Housing

Tailstock Assembly

Drive Shaft Repair

NOTE: Refer to "Section 2, Part D" for drive shaft removal and installation.

1. Replace universal joints, if required.
2. Replace flange, if required.
3. Drive shaft cannot be repaired. Order complete replacement assembly (from Mercury Marine) if required.



a - Drive Shaft Assembly
b - Universal Joint
c - Flange
d - U Bolt (2)
e - U Bolt Nut (4)
f - Yoke - For Replacement, Refer to "Section 8, Part A"

Drive Shaft Assembly

Propeller Shaft (MIE Inboard Models)

NOTICE

The following information can be used as a guide for determining vibration problems on boats powered by inboard engines (MIE Models). For installation, alignment and repairs to shafts, struts, shaft logs and rudders, refer to boat manufacturer's service manual. If boat is equipped with a remote mounted V-Drive, refer to V-Drive or boat manufacturer's service manual for all servicing and troubleshooting. For MIE engine installation and alignment, refer to "Section 2, Part E".

Checks Made While Boat Is in Water

1. Disconnect propeller shaft coupling from transmission coupling.
2. Check fit of coupling to propeller shaft.

Straight Bore Type:

a. Loosen set screws.

b. Try to move coupling by hand. The bore of the coupling should be a semi press fit to shaft.

c. Check shaft for wear. If worn, replacement of shaft may be necessary.

d. If shaft is not worn, try another coupling.

Tapered Bore Type:

a. Check nut on shaft for tightness.

b. If nut was loose, remove coupling and check for damage to taper on shaft or in coupling.

c. Replace worn parts.

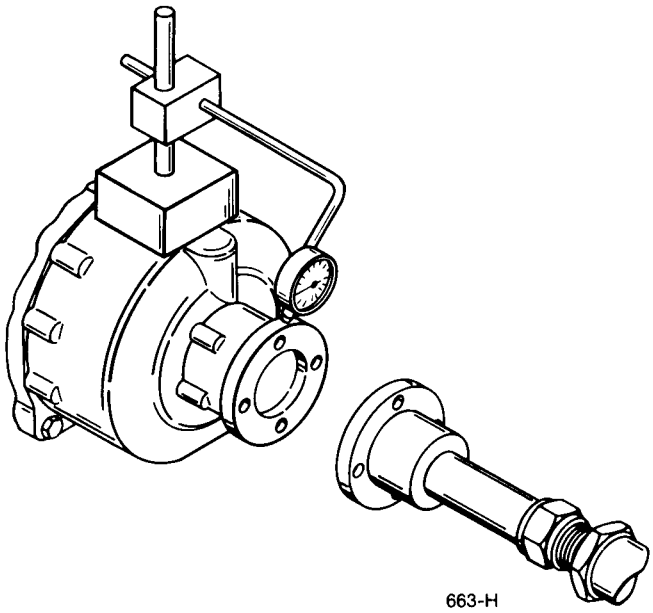
d Always make sure key is not sticking out of coupling.

e. Install coupling on shaft without the key.

f. Mark the shaft (behind the coupling); then, remove the coupling.

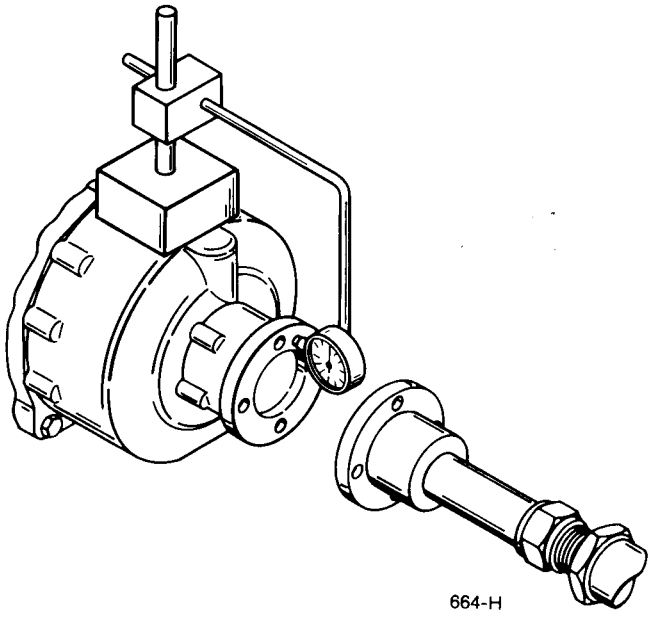
g. Now install the key and coupling Make sure coupling still lines up with the mark. This ensures that key is not oversize and holding the tapers apart.

3. Check output coupling flange of transmission.



663-H

Checking Coupling Outside Diameter - Rotate 1 Complete Turn



664-H

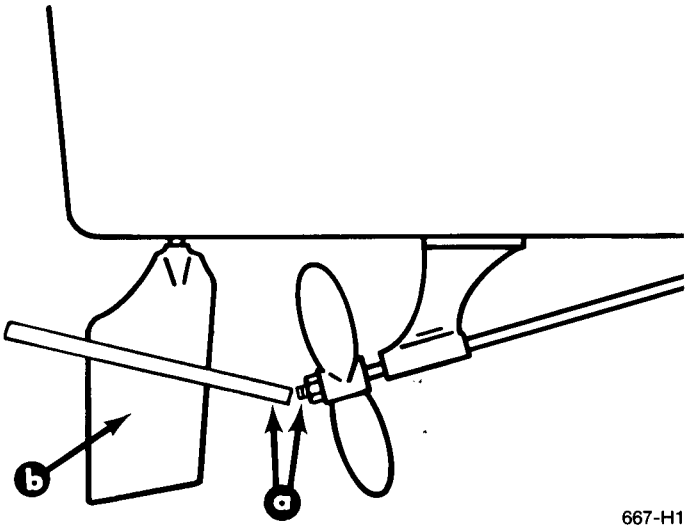
Checking Coupling Face - Rotate 1 Complete Turn

4. If there is movement in step 3, replace output coupling.
5. Replace damaged parts and realign engine as outlined.

Checks Made with Boat Out of Water and Shaft Installed

Possible causes for vibration may be propeller shaft, propeller to shaft fit or propeller. All three can be checked by using the rudder, a strong metal straight edge and a "C" clamp.

1. Check installation of propeller to shaft.
   a. Remove propeller.
   b. Check for chipped or cracked keyway in propeller on shaft without key.
   c. Install propeller on shaft without key.
   d. Mark the shaft (behind the propeller); then, remove propeller.
   e. Install the key and propeller. Make sure propeller still lines up with mark. This ensures that key is not oversize and holding the tapers apart. Retighten propeller nut.
   f. Be sure key is not sticking out of propeller.
2. Check for propeller shaft being bent behind the strut.

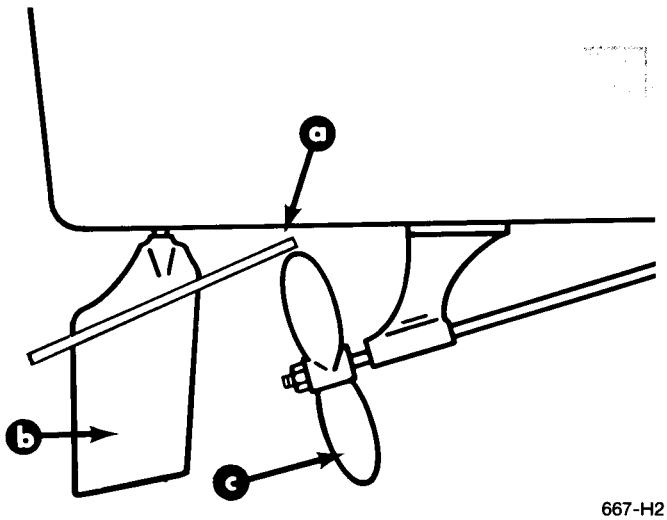


667-H1

a - Metal Straight Edge (Held to Rudder with'C" Clamp) - Position Corner of Straight Edge at Center of Shaft. Rotate Shaft 1 Complete Turn. If Shaft "Wobbles", Replace Shaft.
b - Rudder

Checking for Bent Shaft

3. Check the diameter of all propeller blades. If not the same, repair propeller.

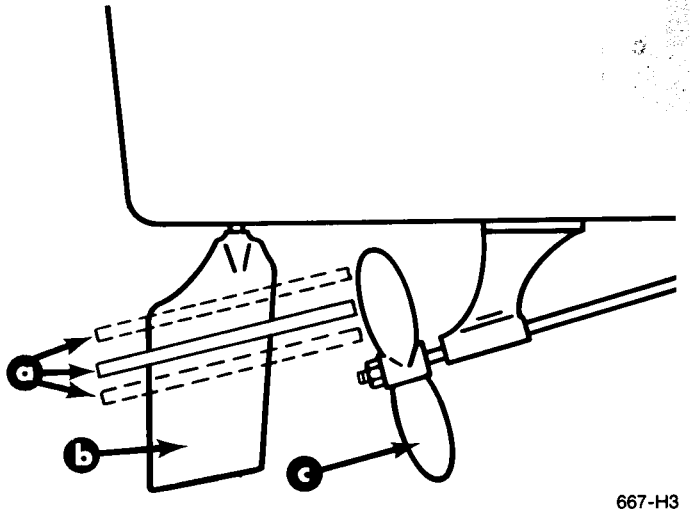


667-H2

a - Metal Straight Edge (Held to Rudder with 'C" Clamp)
b - Rudder
c - Rotate Propeller 1 Complete Turn

Checking Propeller Diameter

4. Check that all propeller blades are the same pitch and that it is properly seated on shaft. Repair or replace if necessary.



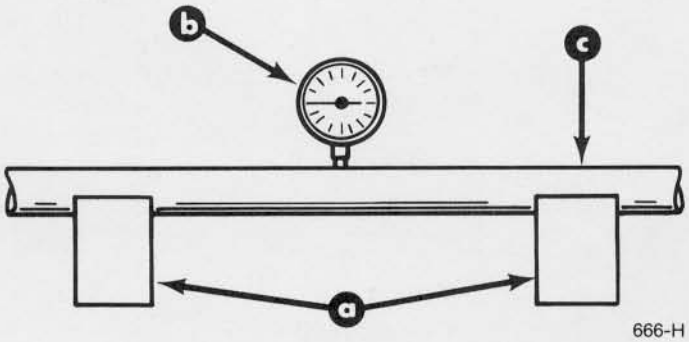
667-H3

a - Metal Straight Edge (Held to Rudder with "C" Clamp)
b - Rudder
c - Rotate Propeller 1 Complete Turn. Check at 3 Different Points on Blades

Checking Propeller Pitch and for Proper Seating

Checks Made with Propeller Shaft Removed from Boat

1. Check propeller shaft for straightness. Check at 3 or 4 places. Any bend over .004 in. (.1016mm), replace shaft.

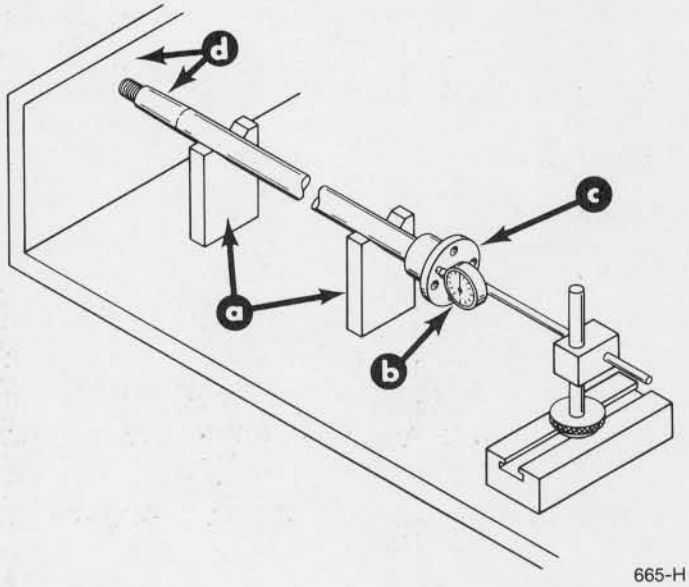


666-H

a - Vee Blocks
b - Dial Indicator
c - Shaft - Rotate 1 Complete Turn

Checking for Bent Shaft.

2. Check that bore of coupling is 90 degrees from coupling flange. Replace coupling if needle moves.



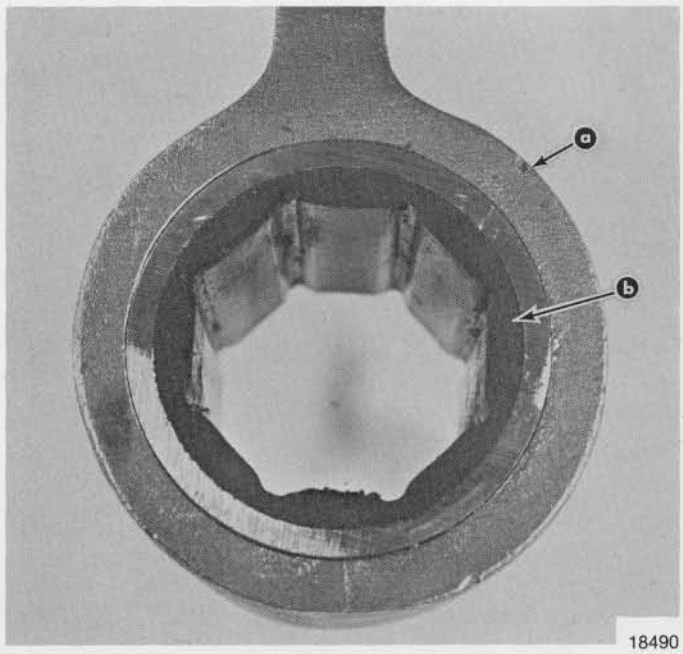
665-H

a - Vee Blocks
b - Dial Indicator
c - Coupling Flange - Rotate 1 Complete Turn
d - Shaft Against Block to Prevent Fore and Aft Movement

Checking Coupling Bore

Strut

Refer to boat manufacturer's service manual for alignment and replacement. Normally, the shaft should be centered in the cutlass bearing. Shims (placed between the strut and hull) are used to align the strut to the shaft.



18490

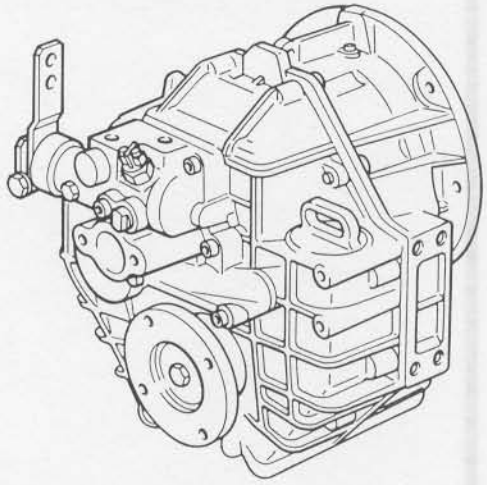
a - Strut
b - Cutlass Bearing

Strut

DRIVE SYSTEMS

8

C



25280

HURTH TRANSMISSION

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Torque Specifications

Transmission Housing Halves Bolts and Nuts ..... 36 lb. ft. (49 N.m)

Control Block To Housing Bolts ..... 18 lb. ft. (25 N.m)

Output Flange ..... 62 lb. ft. (83 N.m)

Mounts ..... 50 lb. ft. (68 N.m)

Transmission To Flywheel Housing ..... 50 lb. ft. (68 N.m)

Lubricants/Sealants

Loctite Type "A" (Screws/Bolts/Flange)

Loctite 515 (Split-Line)

ATF FLUID - DEXRON II
- MOBIL 423

Operating Specifications

Shifting Pressure	312-377 psi (2151-2599 kpa)
Operating Temperature	130°-250° F (54°-121° C)

MERCURY MARINE SPECIAL TOOLS

Description	Part No.
Tapered Roller Bearing Inner Race Puller	91-813950
Tapered Roller Bearing Outer Race Puller	91-813951
Pressure Plate Removal Tool-Reversing Clutch	91-813952
Tapered Roller Bearing Inner Race Puller Plate	91-813953
Pressure Plate Installation Tool-Reversing Clutch	91-813954
Mandrel - Input Shaft Seal	91-813955
Mandrel - Output Shaft Seal	91-813957
Preload Tool - Input Shaft	91-813957
Preload Tool - Intermediate Shaft	91-813958

OTHER TOOLS

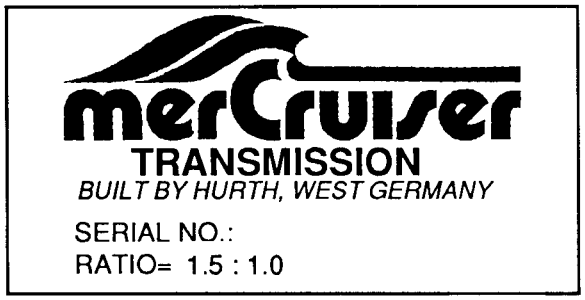
Pressure Gauge (M10X1 Thread)
0-450 psi

Thermometer (3/8 in. Thread)
0-270° (-18° — 132°C)

Output shaft dia at seal area
2.1579" - 2.1654"
54.81 mm - 55.0 mm

Identification

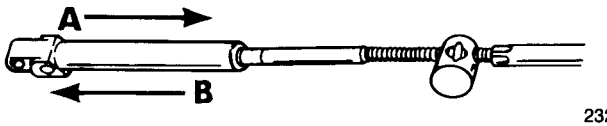
The transmission identification plate is located on the top-rear of the transmission.



NOTE: All engines are LH rotation as viewed from flywheel end of engine.

IMPORTANT: Transmission propeller rotation is determined by the shift cable installation in the remote control.

- RIGHT HAND ROTATION - Control cable will have to be installed in remote control so that cable end will move in direction "A" when shift handle is placed in the forward position.
- LEFT HAND ROTATION - Control cable will have to be installed in remote control so that cable end will move in direction "B" when shift handle is placed in the forward position.



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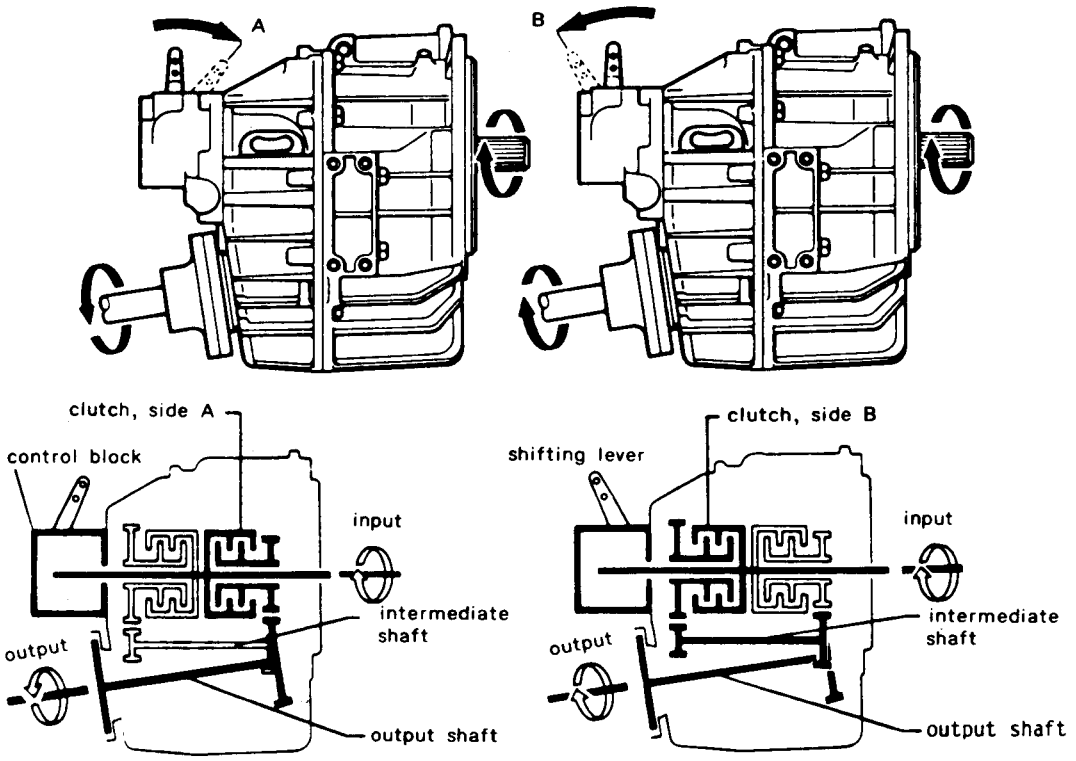


25506

"A" is Forward Gear for RH Rotation Propeller

"B" is Forward Gear for LH Rotation Propeller

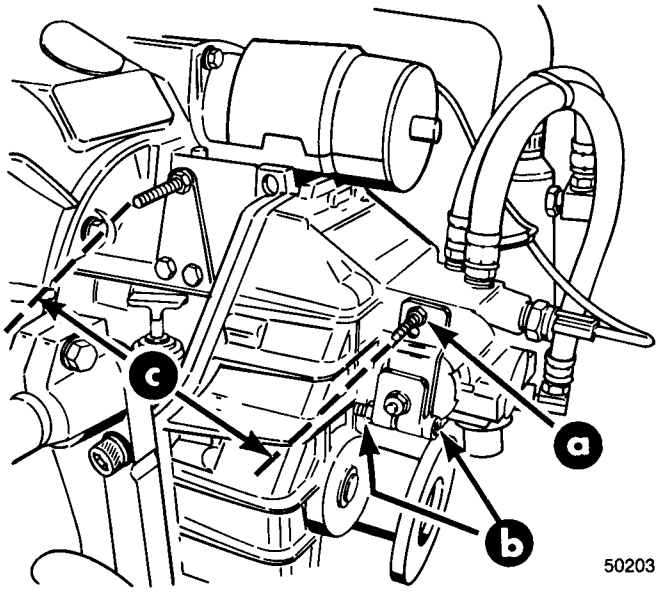
Shifting lever in position	Propeller rotation	Propeller
A	opposite to engine rotation	Right hand (RH)
B	Same as engine rotation	Left hand (LH)

TRANSMISSION RATIOS

Nominal transmission ratio	1.5	2.0	2.5
Transm. ratio shifting pos. "A" (forward gear)	1.56	2.04	2.52
Transm. ratio shifting pos. "B" (reverse gear)	1.58	2.10	2.53

Shift Cable Installation and Adjustment

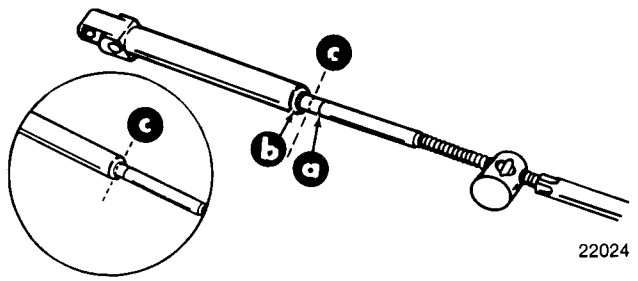
IMPORTANT: Check that shift lever is positioned approximtely 10° aft, when in the neutral detent position. To determine this, measure between studs, as shown. If necessary, loosen clamping bolt, position properly and retighten bolt.



50203

a - Shift Lever
b - Clamping Bolt
c - Dimension Between Studs; 7-1/8 in. (317.5mm)

1. Place remote control shift lever, and transmission shift lever, in neutral position.
2. Remove nuts and washers from shift cable attaching studs.
3. Locate center of remote control and control shift cable play (backlash) as follows:
   a. Check that remote control is in neutral position.
   b. Push in on control cable end with enough pressure to remove play, and mark position "a" on tube.
   c. Pull out on control cable end with enough pressure to remove play, and mark position "b" on tube.
   d. Measure distance between marks "a" and "b", and mark position "c", half-way between marks "a" and "b".

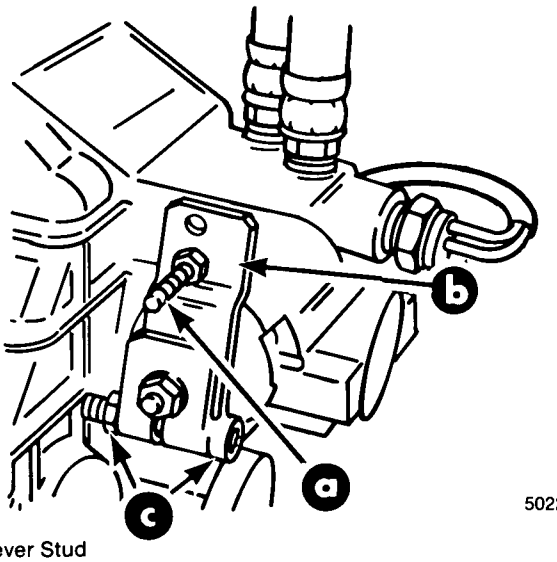


22024

4. Center cable-end play, then adjust cable barrel to align holes in barrel, and in cable end guide, with attaching points on transmission.
5. Temporarily install shift cable. Do not secure at this time.

IMPORTANT: Transmission is "fully" in gear when shift lever comes to a stop, in either direction.

6. Place remote control shift lever in the forward gear position. Check to ensure transmission is fully in gear, as follows.
   a. Hold shift lever in position.
   b. Carefully slide shift cable off of anchor points.
   c. Attempt to move shaft lever further.
7. Place remote control shift lever in the reverse gear position. Check that transmission is fully in gear, following same procedure.
8. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in both gears, move transmission shift lever stud (a), from top hole in shift lever, to bottom hole, and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.

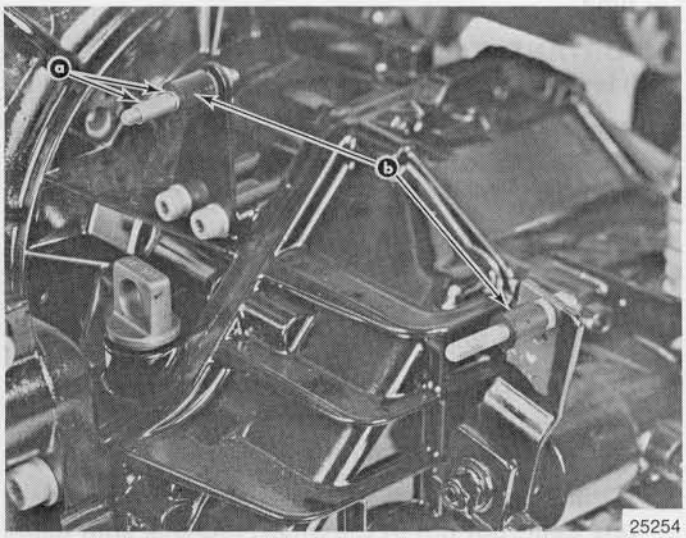


50228

a - Shift Lever Stud
b - Lever
c - Clamping Bolt

9. Once shift cable adjustment is correct, secure shift cable(s) with hardware as shown, referring to appropriate configuration following.

SINGLE CABLE - FORWARD ENTRY



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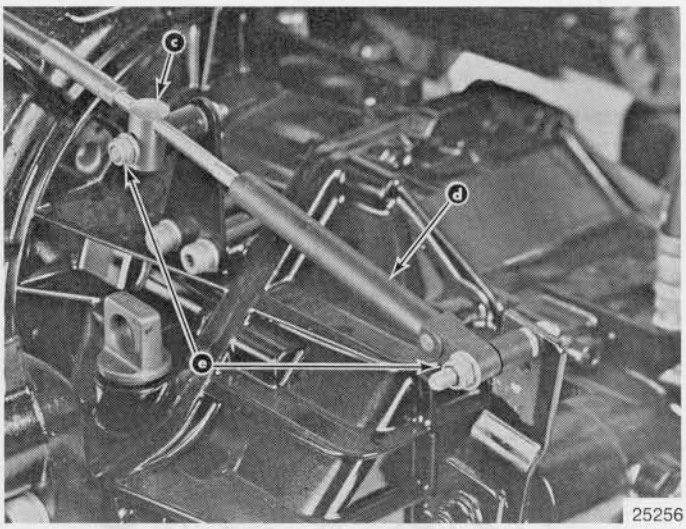
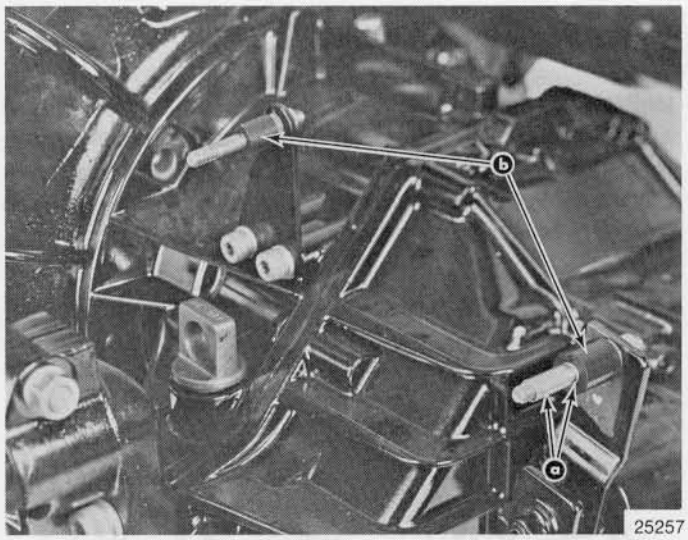


25256

a - Sleeves (2)
b - Spacer
c - Shift Cable Barrel
d - Shift Cable End Guide
e - Washer and Locknut (Tighten Until Bottomed, Then Back Off 1/2 Turn)

SINGLE CABLE - REAR ENTRY



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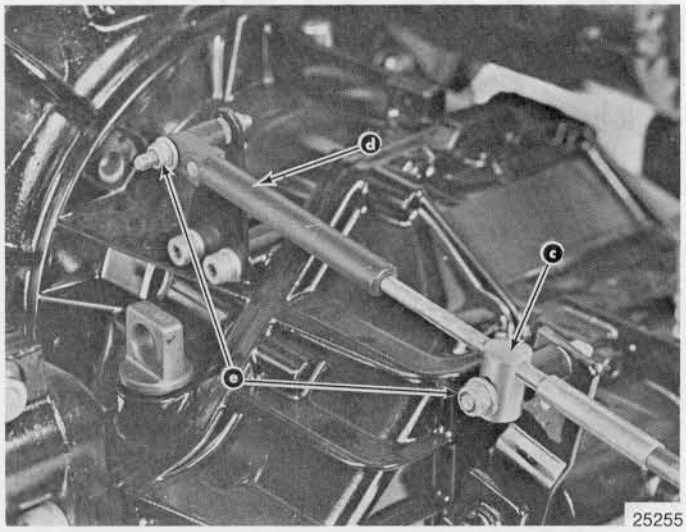
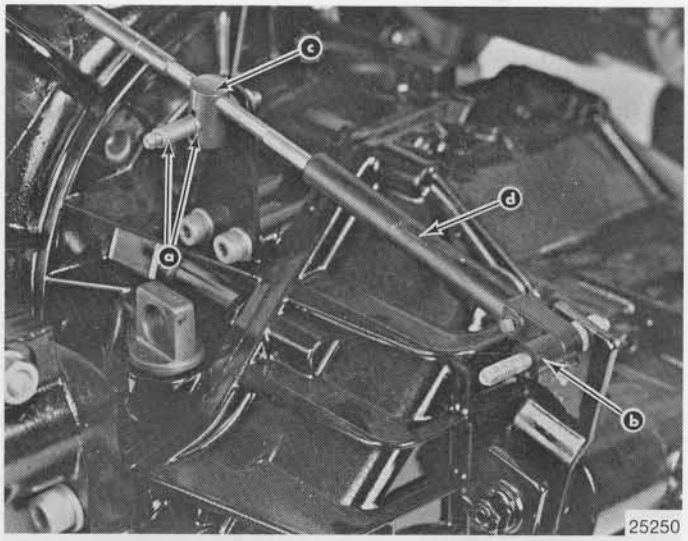


25255

a - Sleeves (2)
b - Spacer
c - Shift Cable Barrel
d - Shift Cable End Guide
e - Washer and Locknut (Tighten Until Bottomed, Then Back Off 1/2 Turn)

DUAL CABLE - FORWARD ENTRY



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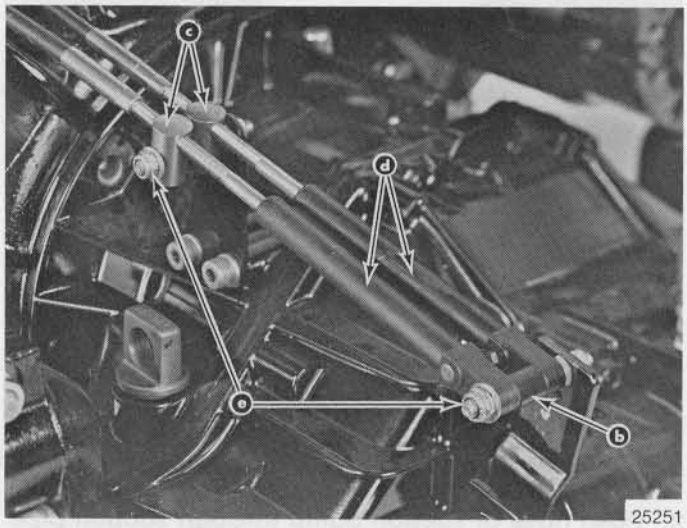
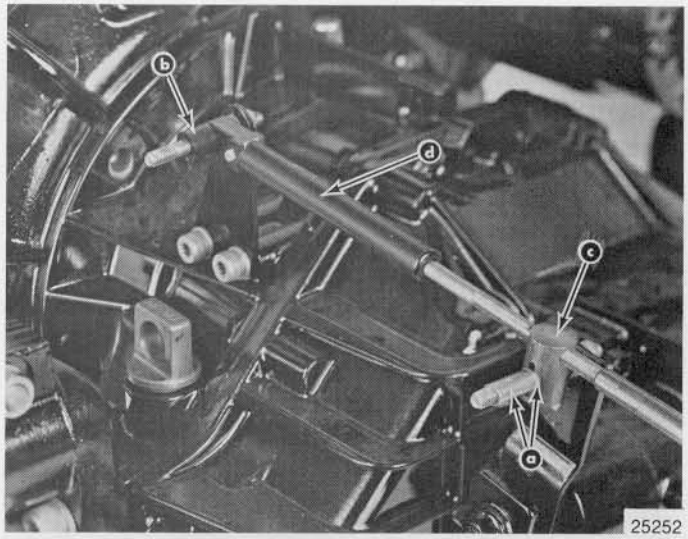


25251

a - Sleeves (2)
b - Spacer
c - Shift Cable Barrel(s)
d - Shift Cable End Guide(s)
e - Washer and Locknut (Tighten Until Bottomed, Then Back Off 1/2 Turn)

DUAL CABLE - REAR ENTRY



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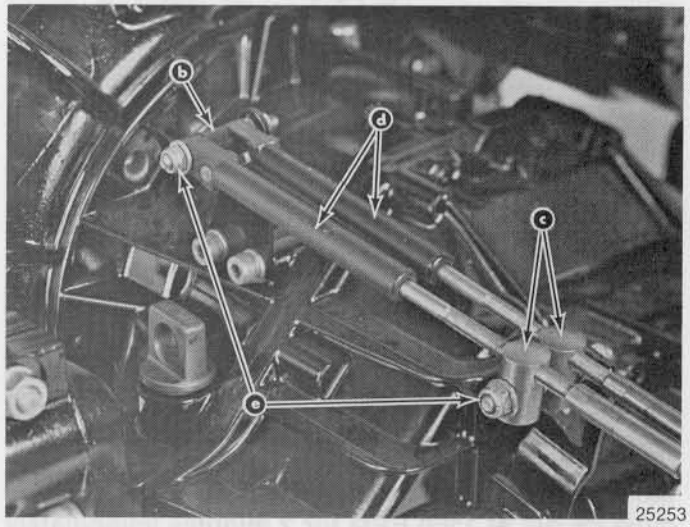


25253

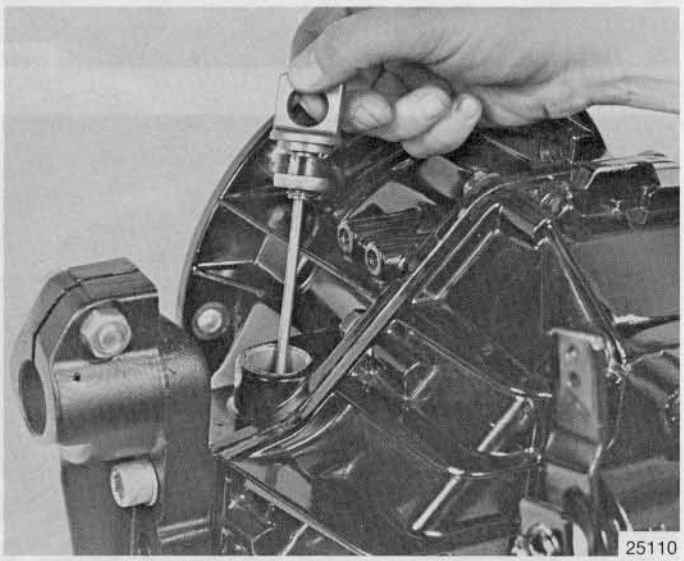
a - Sleeves (2)
b - Spacer
c - Shift Cable Barrel(s)
d - Shift Cable End Guide(s)
e - Washer and Locknut (Tighten Until Bottomed, Then Back Off 1/2 Turn)

Checking Transmission Fluid Level

IMPORTANT: Use only specified transmission fluid. (see "Specifications").

Check transmission fluid before starting engine each day, as follows:

1. Remove dipstick. Check fluid level as indicated on dipstick. Fluid level may be somewhat over full mark, as some of the fluid from transmission fluid cooler and hoses may have drained back into transmission. If low, add transmission fluid to bring level up to full mark on dipstick.


25110

IMPORTANT: To accurately check fluid level, engine must be run at 1500 RPM for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for 2 minutes to fill all hydraulic circuits.

IMPORTANT: Be sure to push dipstick all-the-way down into dipstick tube when checking fluid level.

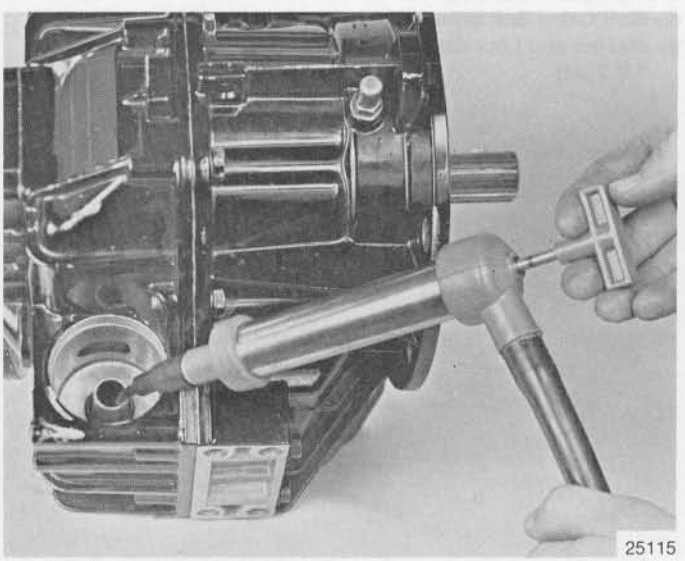
3. Stop engine and quickly check fluid level. Add automatic transmission fluid, if necessary, to bring level up to full mark on dipstick. (Refer to "Filling Instructions" following)
4. Reinstall dipstick.
5. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

Draining Transmission

1. Clean the exterior of transmission before disassembly.
2. Remove oil filter from housing by turning (counterclockwise) and pulling at the same time.

25112

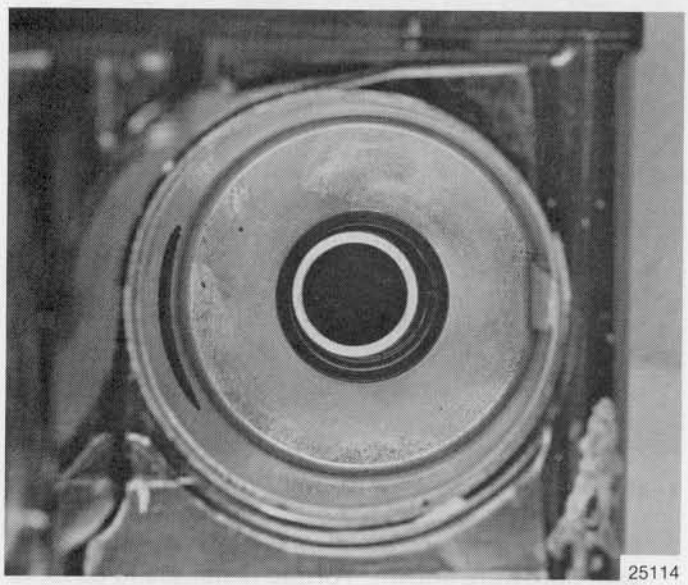
3. Push hose of suction pump through suction pipe and down to the bottom of the housing. Pump fluid from housing.

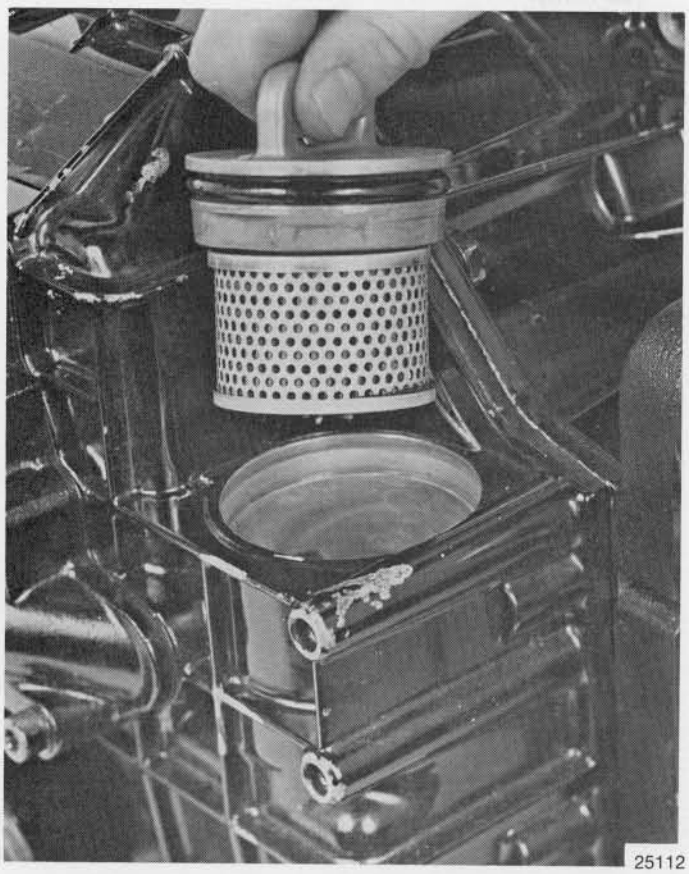

25115

Filling Transmission

IMPORTANT: Use only ATF (Automatic Transmission Fluid), such as, Mobil 423 or Dexron II.

1. Fill transmission to proper level, thru oil filter cavity. (Refer to specifications for capacity).
2. Install filter as follows:
   a. Coat o-ring on filter cover with transmission fluid.
   b. Bring flat spot on filter cover in line with flat surface inside of housing.

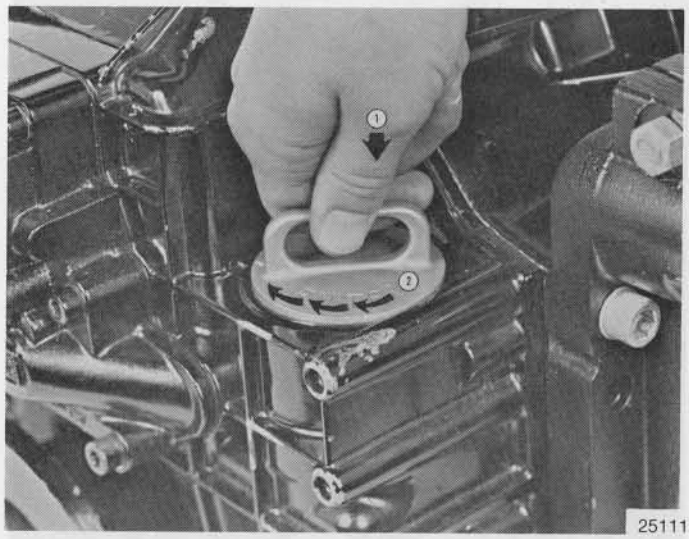

25114


25112

⚠CAUTION

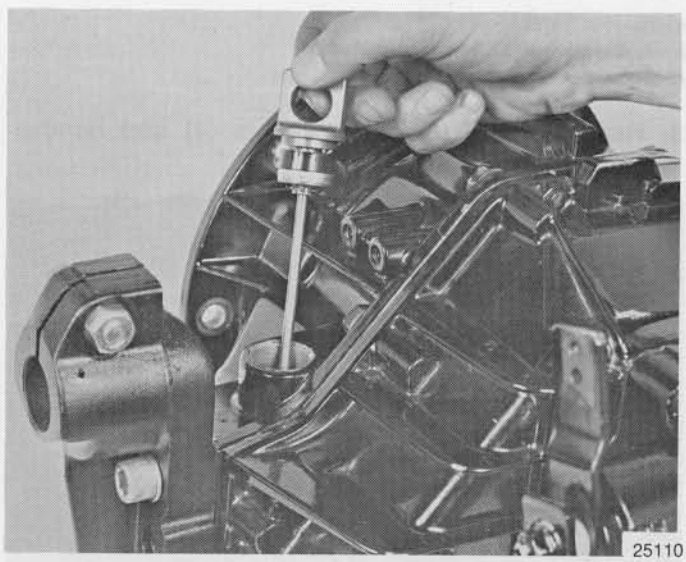
Transmission fluid filter and cover must be properly seated to avoid fluid foaming and/or loss of fluid, thus resulting in decreased efficiency and/or damage to transmission.

   c. Push down until cover is fully seated (top of cover flush with housing), then, turn cover clockwise until tight.



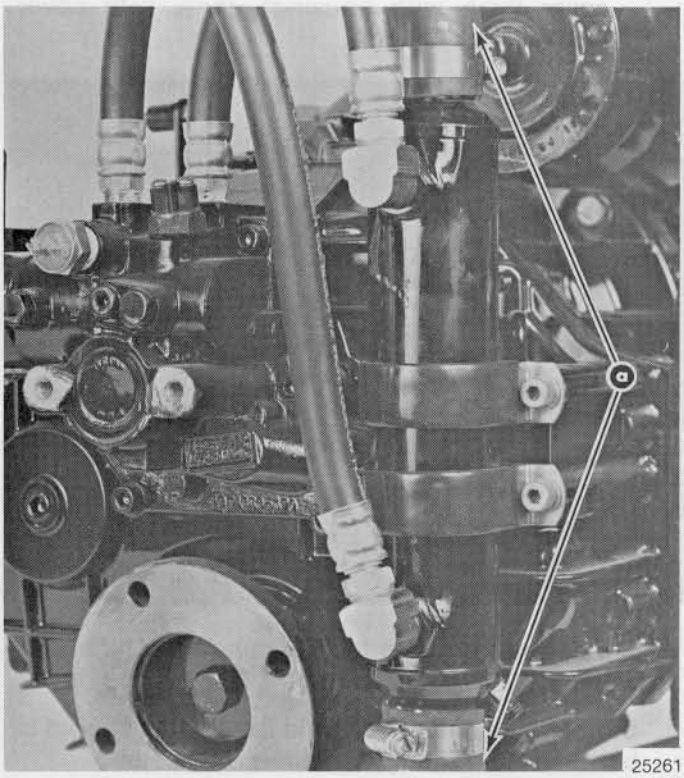
25111

3. Start engine and run for two minutes to fill system with fluid.
4. Stop engine and check fluid level. Fluid should be between "Min" and "Max" lines on dipstick.


25110

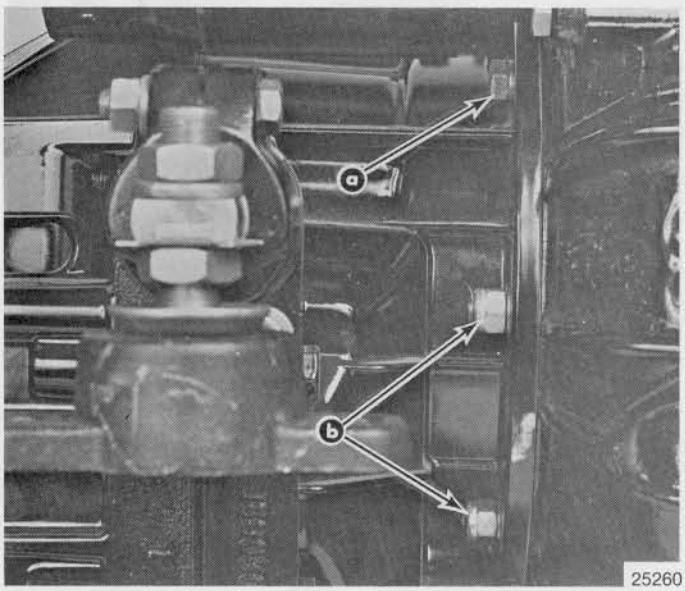
Transmission Removal

1. Disconnect wires from neutral safety switch and audio warning temperature switch.
2. Disconnect seawater hoses from transmission fluid cooler.



a - Neutral Safety Switch
b - Audio Warning Temperature Switch
c - Seawater Hoses

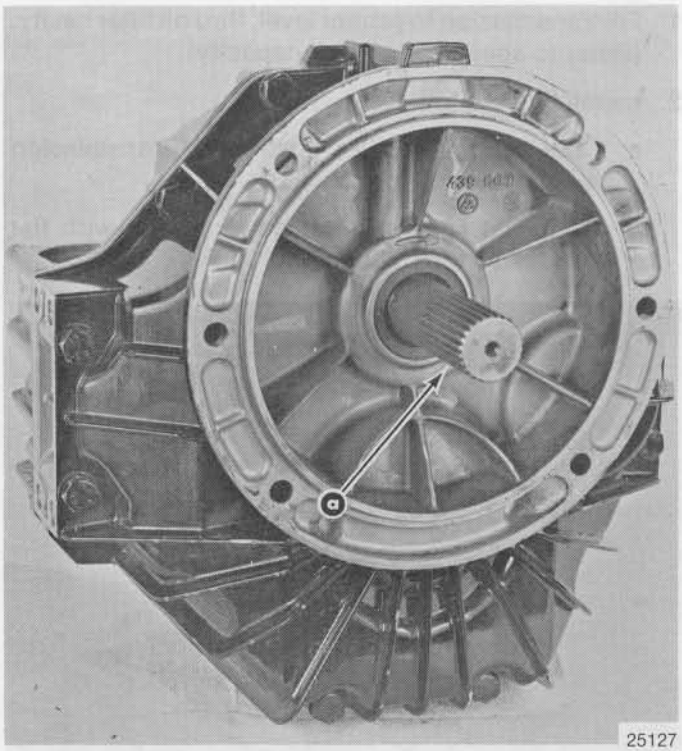
3. Remove bolts (2) and locknuts (4) and remove transmission.



a - Bolts [(2) One On Each Side]
b - Locknuts [(4) Two On Each Side]

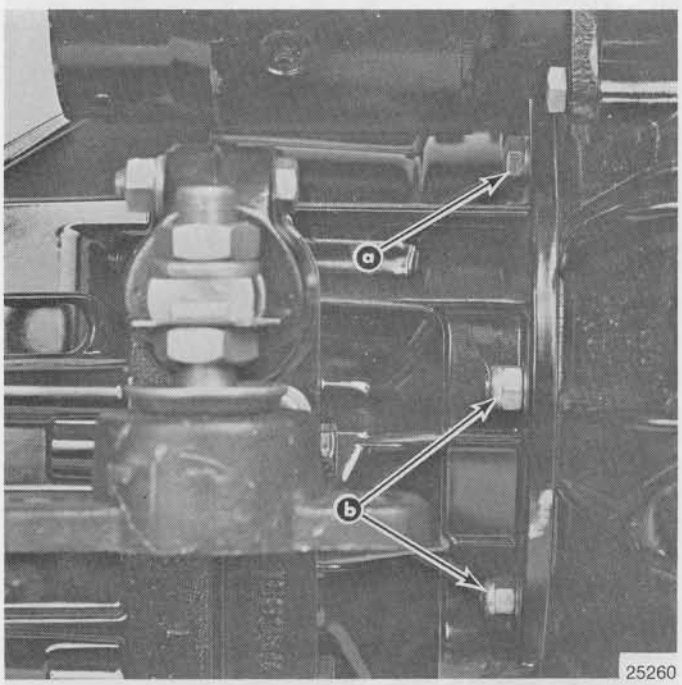
Transmission Installation

1. Coat splines on input shaft with 2-4-C Marine Lubricant.



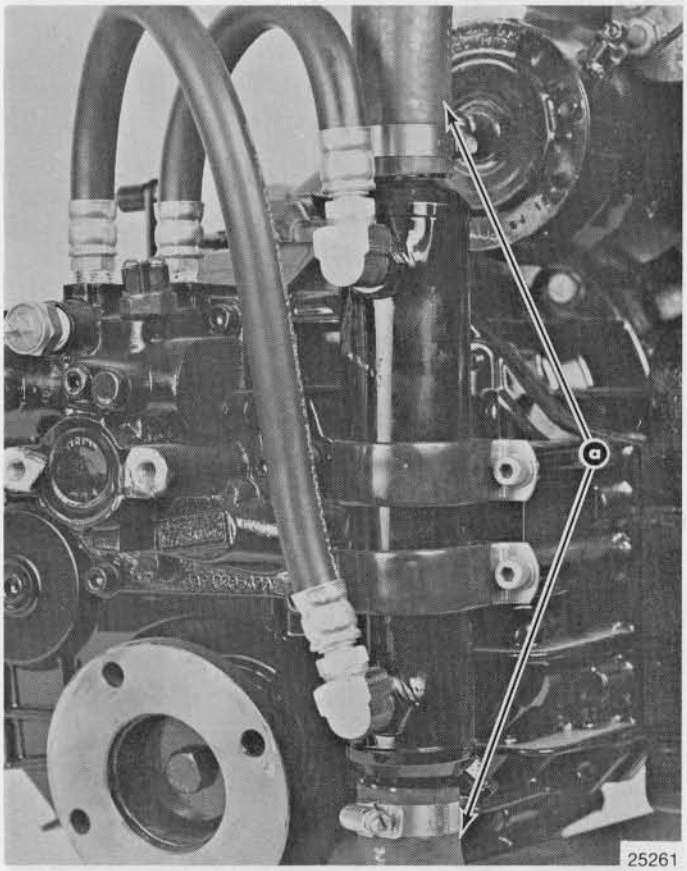
a - Input Shaft

2. Install transmission on flywheel housing and secure with hardware shown. Torque fasteners to 50 lb. ft. (68 N.m).



a - Bolts [(2) One On Each Side]
b - Locknuts [(4) Two On Each Side]

3. Connect seawater hoses to transmission fluid cooler and tighten hose clamps securely.
4. Connect wires to neutral safety switch and to audio warning temperature switch. Coat connections on neutral safety switch with liquid neoprene.



a - Neutral Safety Switch
b - Audio Warning Temperature Switch
c - Seawater Hoses

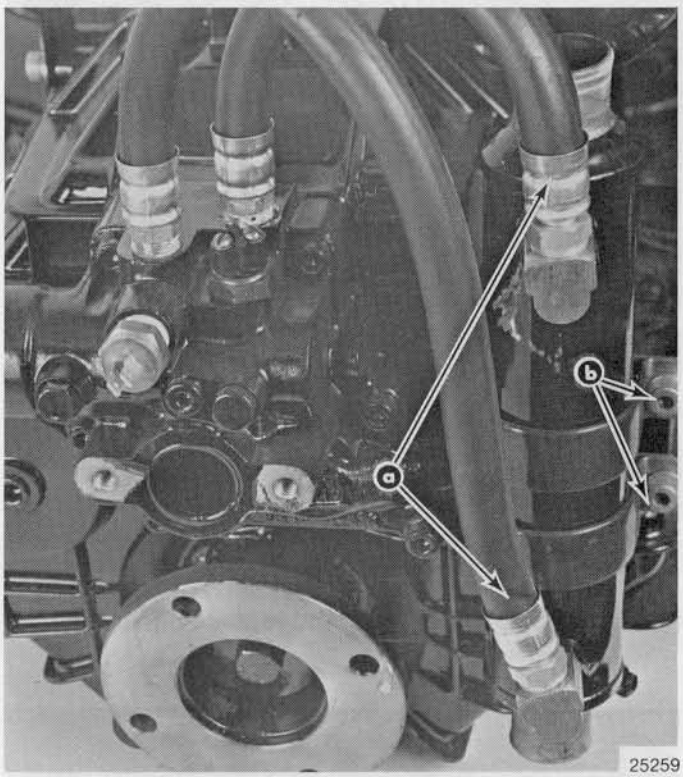
Transmission Repair

DISASSEMBLY

IMPORTANT: Ensure work area is clean before disassembly is started. Be sure to use lint free cloths when cleaning and/or handling parts.

Transmission Fluid Cooler

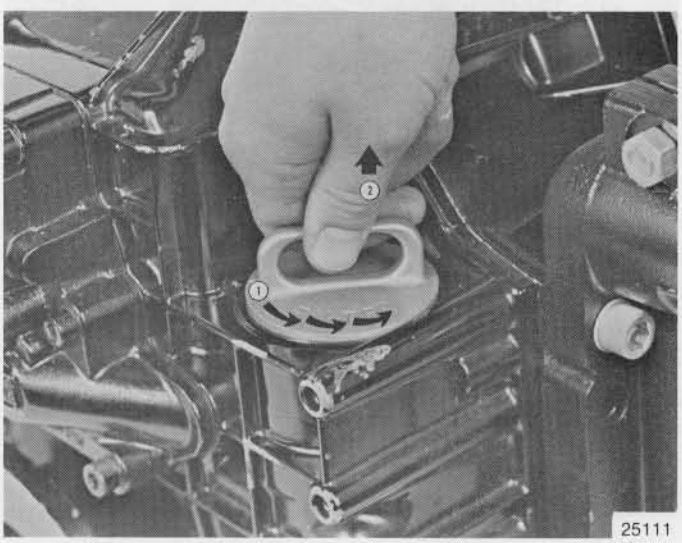
1. Disconnect transmisison fluid hoses from cooler and remove clamps that secure cooler to housing.



a - Transmission Fluid Hoses
b - Clamps

Oil Filter and Dipstick

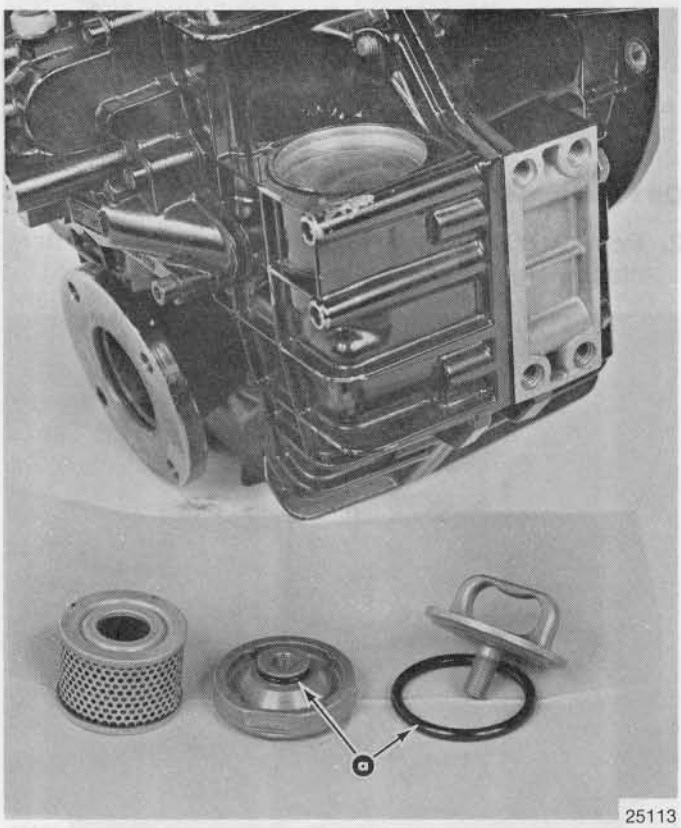
2. Remove oil filter from housing by turning (counterclockwise) and pulling at the same time.



3. Remove filter element from cover.

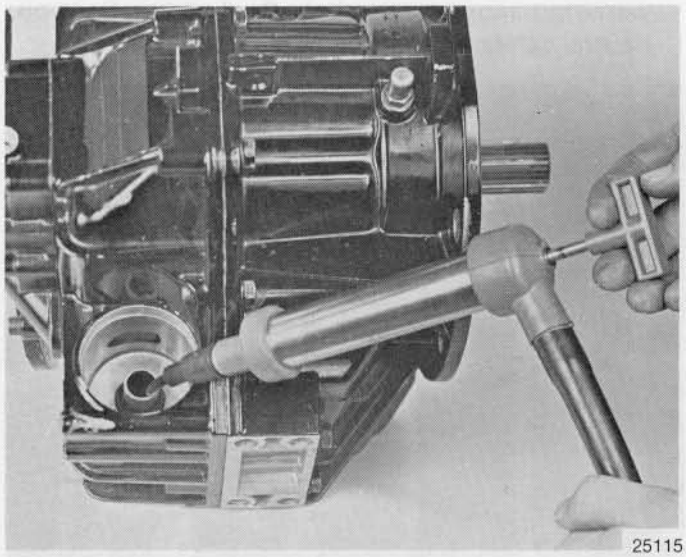
25112

4. Inspect o-rings for wear and replace if necessary.

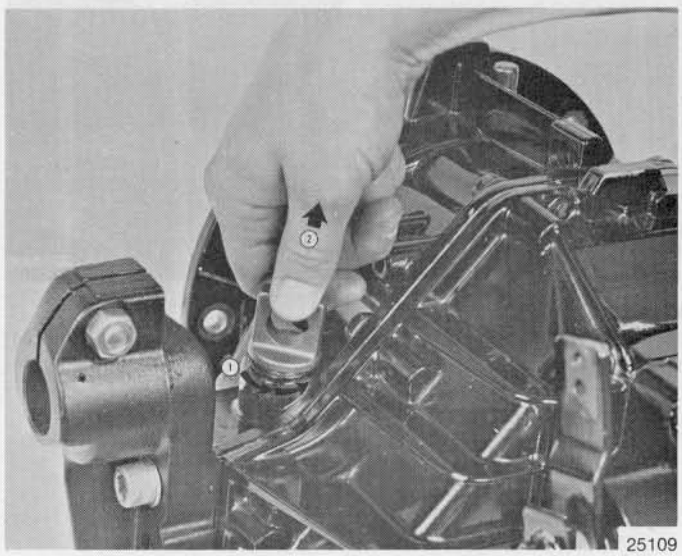

25113

a - O-Rings

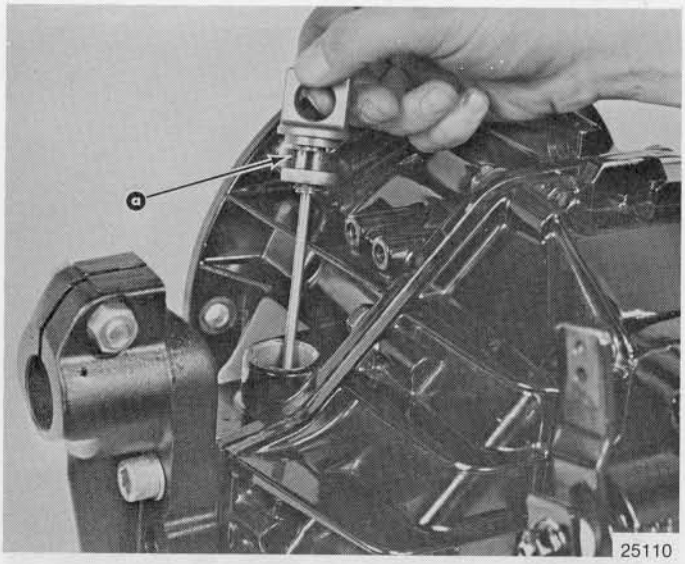
5. Push hose of suction pump through suction pipe and down to the bottom of the housing. Pump fluid from housing.


25115

6. Remove dipstick by turning (counterclockwise) and pulling at the same time.


25109

7. Inspect seal for wear and replace if necessary.



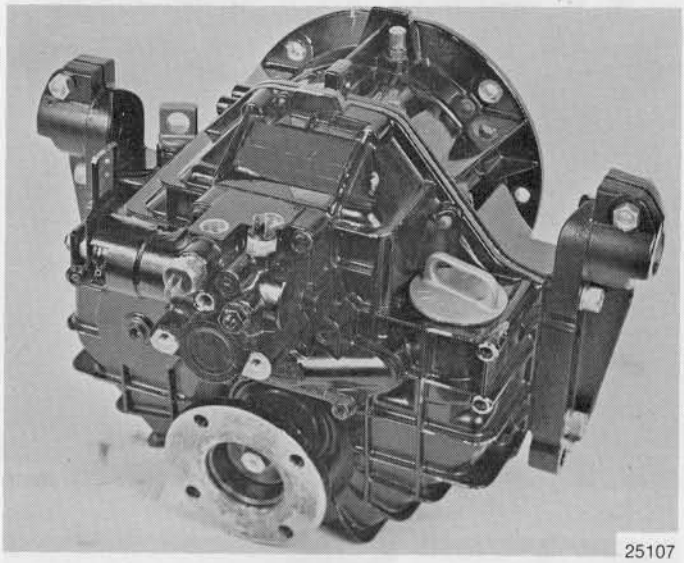
a - Seal

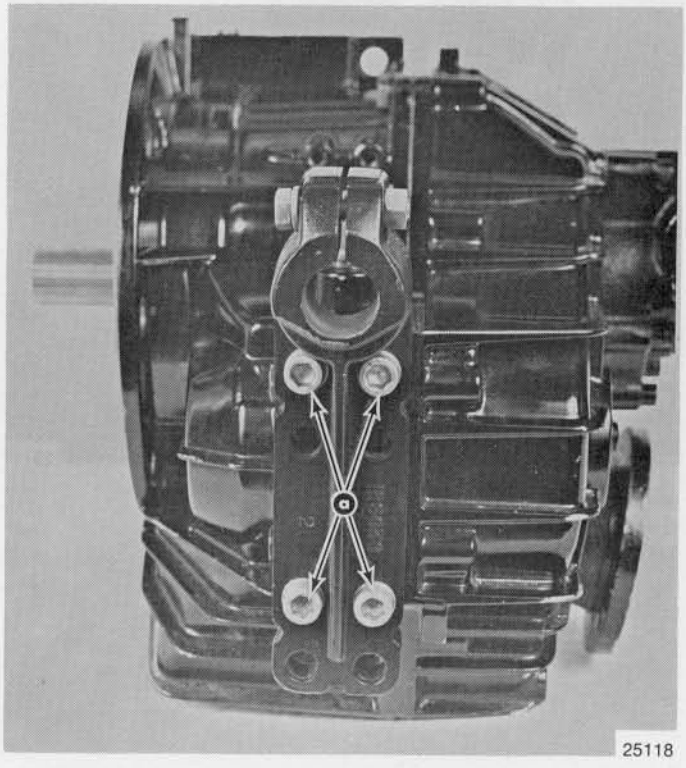
Breather Valve

8. Remove breather valve. Clean with suitable cleaner, allow to dry and coat with oil.

Mounts

9. Remove mounts from transmission housing. Inspect mounts for damage and replace if necessary.

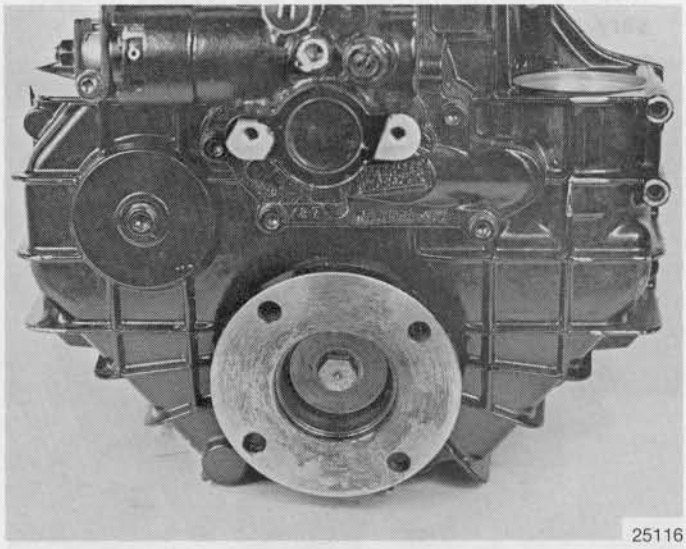


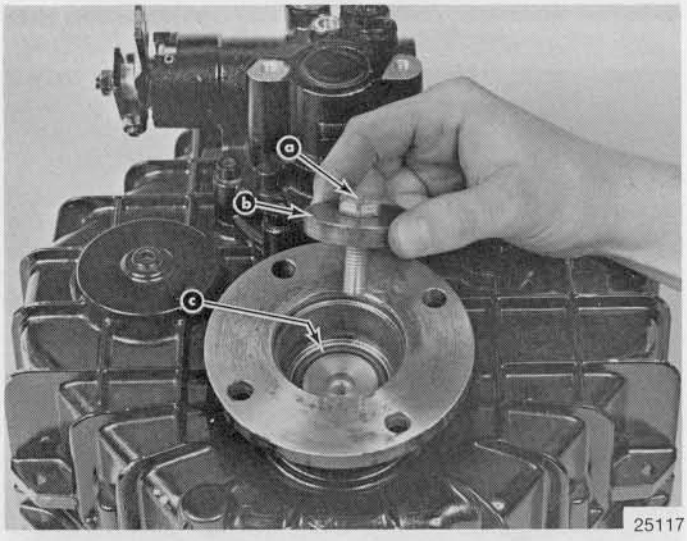


a - Bolts (4 Each Side)

Output Flange

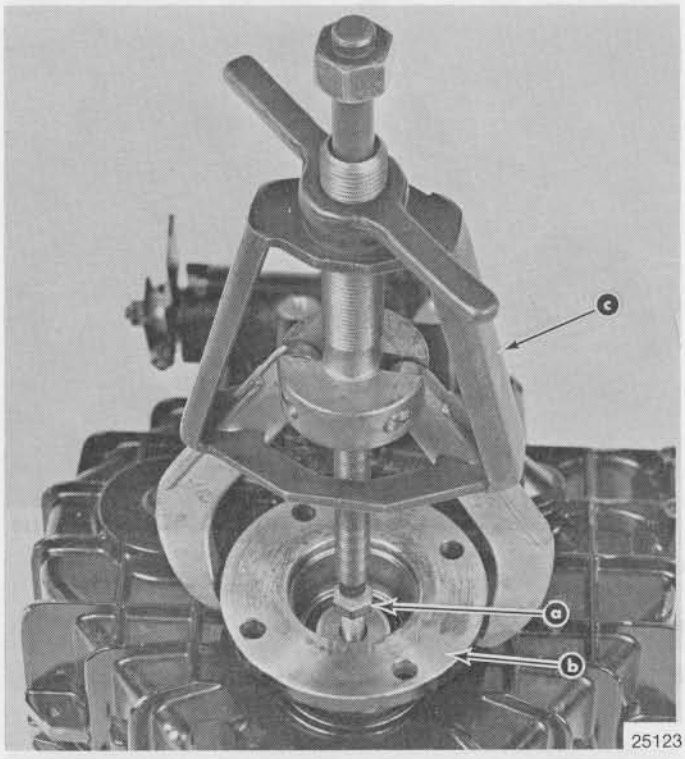
10. Remove bolt, washer and o-ring.

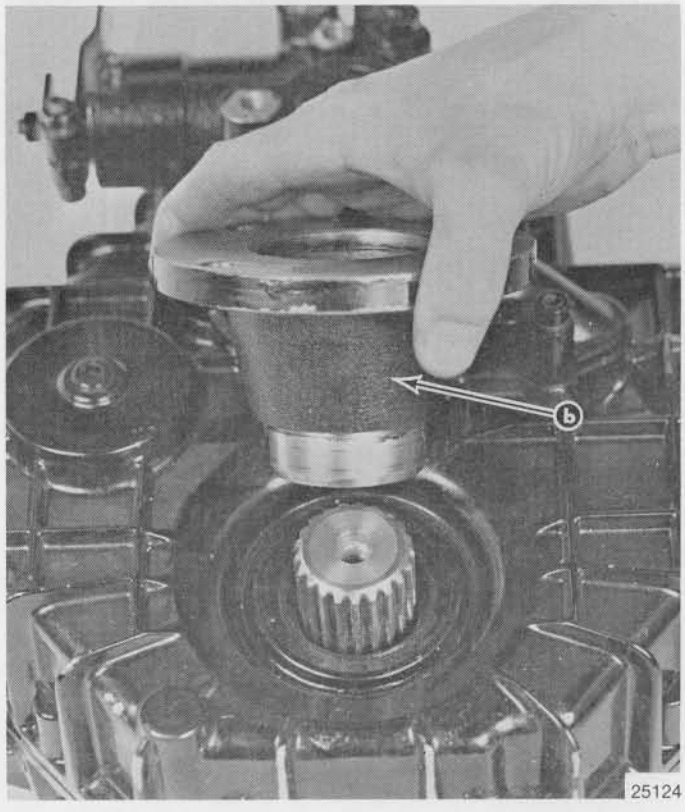




a - Bolt
b - Washer
c - O-Ring

11. Reinstall bolt and remove flange using appropriate puller.

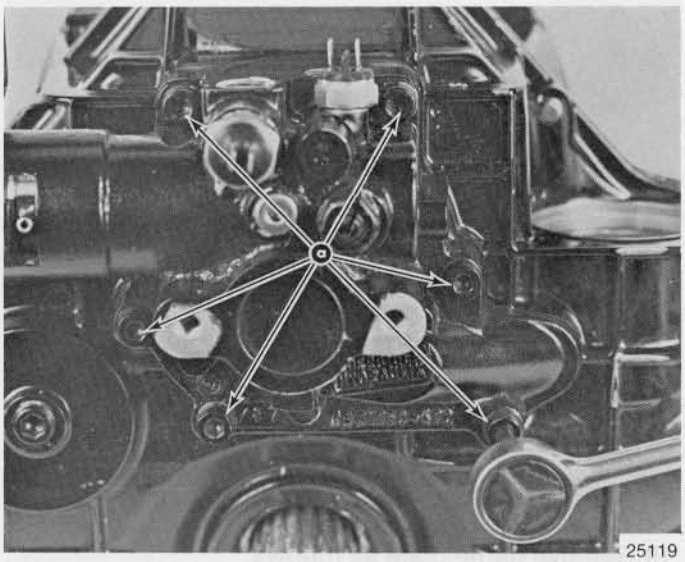




a - Bolt
b - Flange
c - Puller

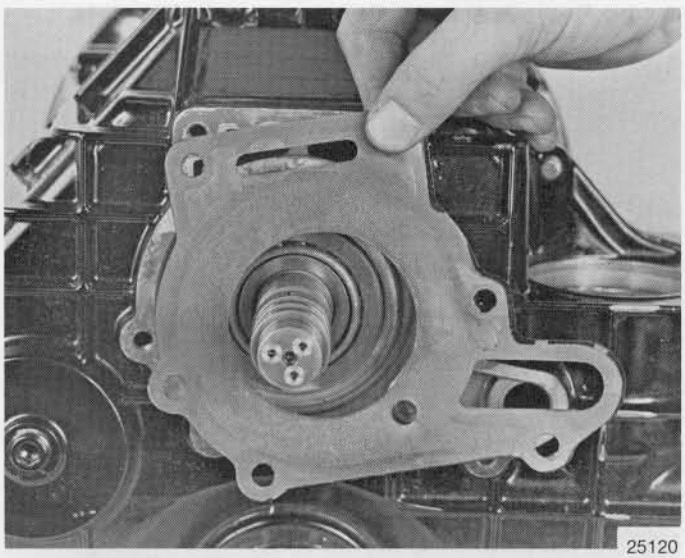
Control Block

12. Remove hex head bolts (6).



25119

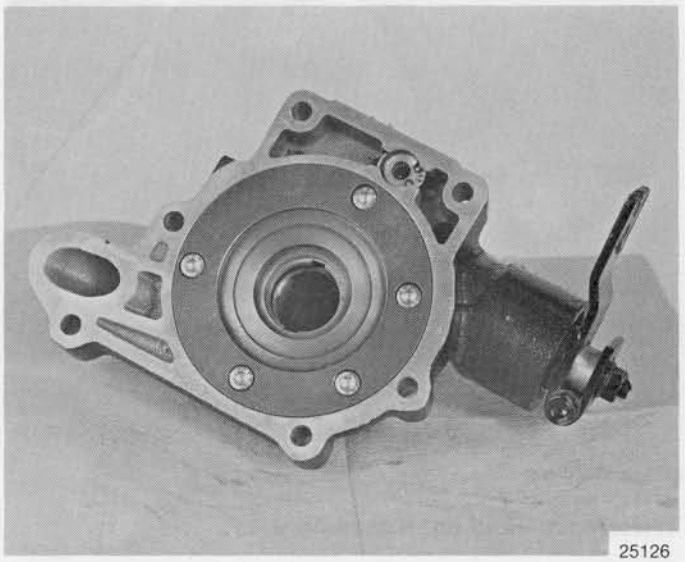
13. Remove control block and gasket from housing.



25120

⚠CAUTION
Be careful not to allow dirt to enter control block from front side.

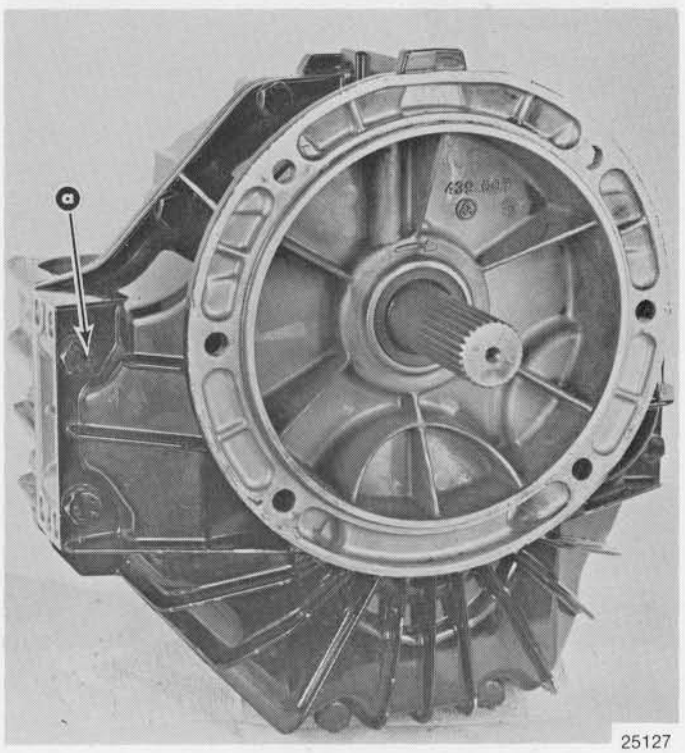
14. Cover openings in control block with a protective cloth.



25126

Housing

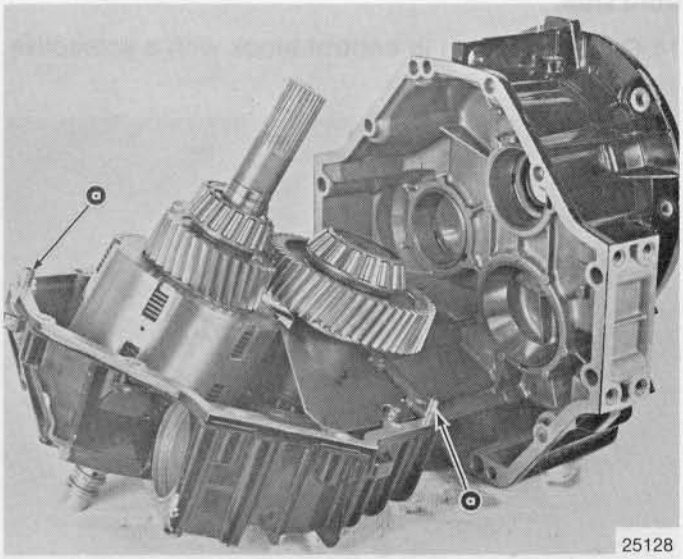
15. Remove hex head bolts (12) from input side of housing.



25127

a - Bolts (12)

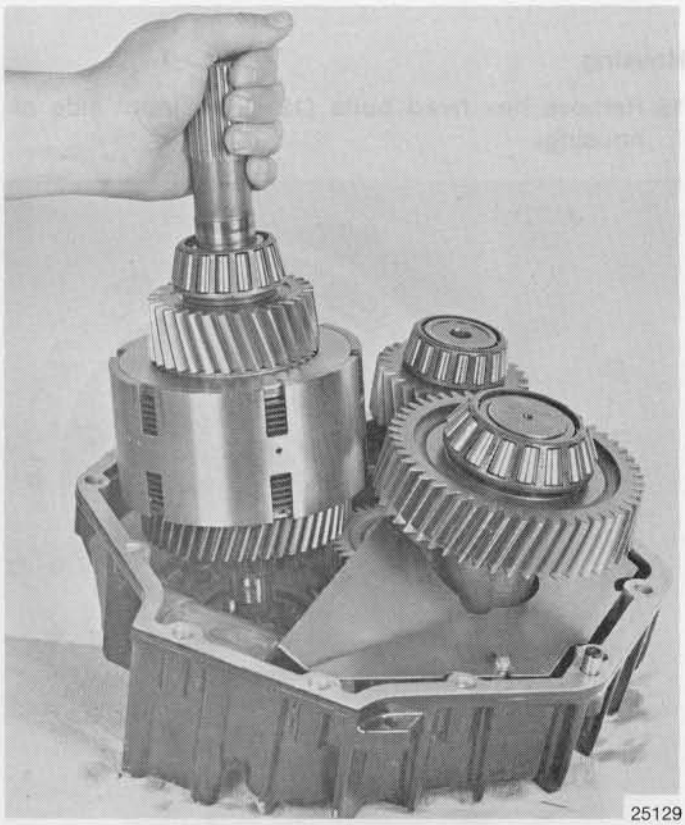
16. Remove input side of housing. Be sure to locate and save locator pins.



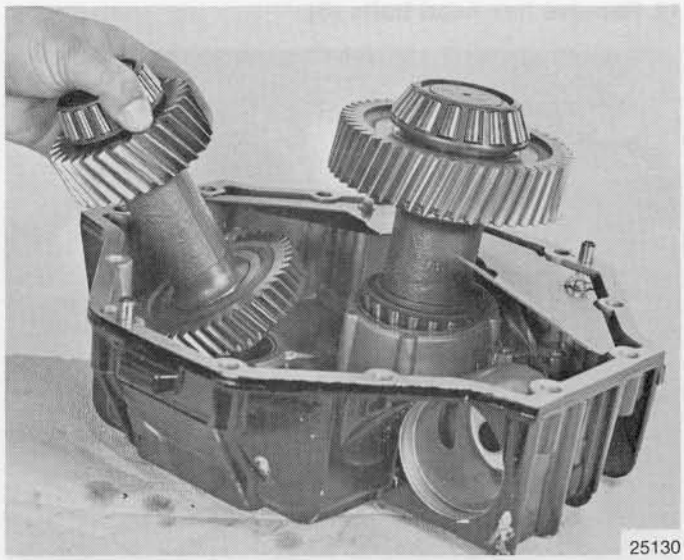
25128

a - Locator Pins

17. Remove input shaft assembly.


25129

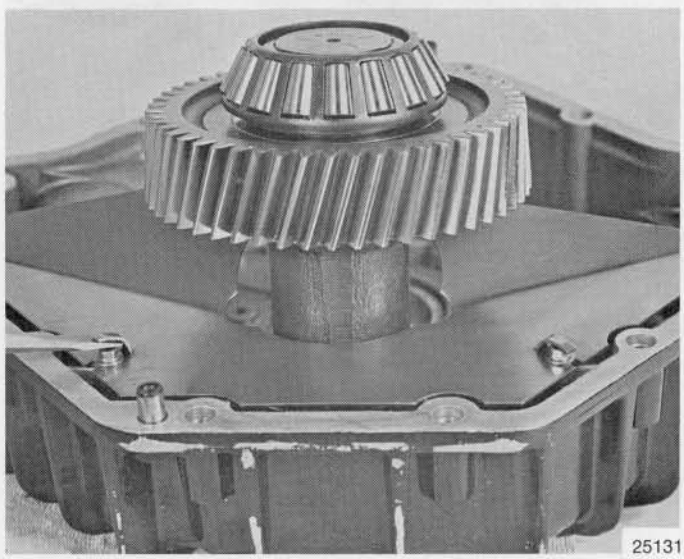
18. Remove intermediate shaft assembly.

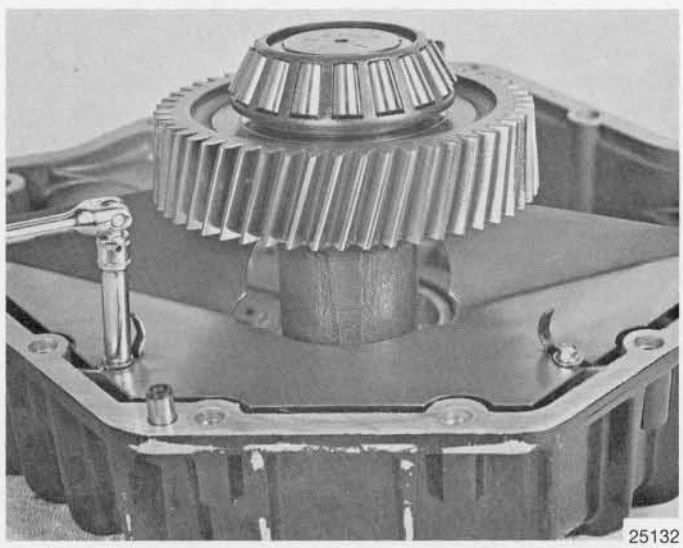

25130

19. Remove baffle plate as follows:

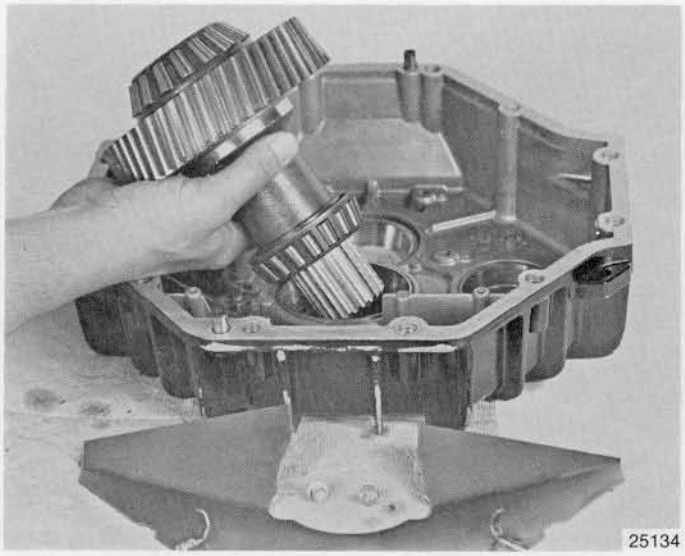
a. Bend tabs up away from screws.

b. Remove screws, then; remove baffle plate.


25131


25132

20. Remove output shaft assembly.



Bearing, Gear and Seal Inspection

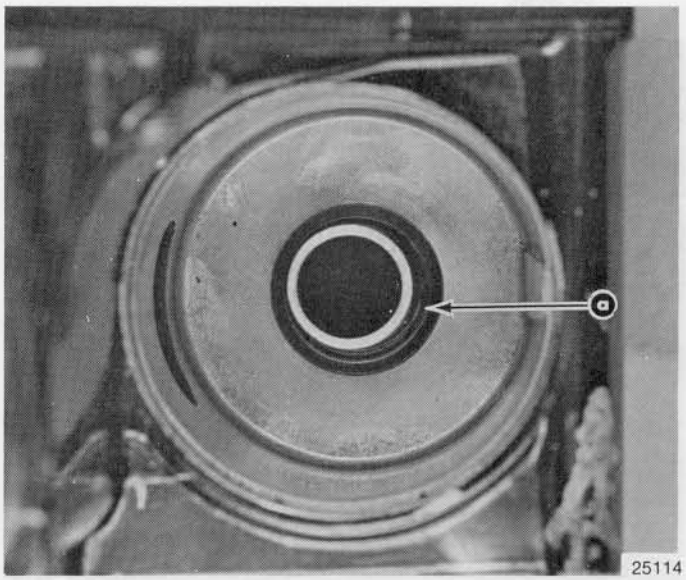
21. Inspect all tapered roller bearings, the piston rings on the input shaft and all gears for wear. If damage has been found on the gearing of the intermediate or output shaft, it is ALWAYS necessary to replace the complete shaft.

    When gears on the input shaft have to be replaced, the tapered roller bearings and needle bearings MUST BE replaced as well.

22. Turn gears of input shaft to check correct operation of the reversing clutch. If it is hard to turn the gears, the clutch is probably damaged.

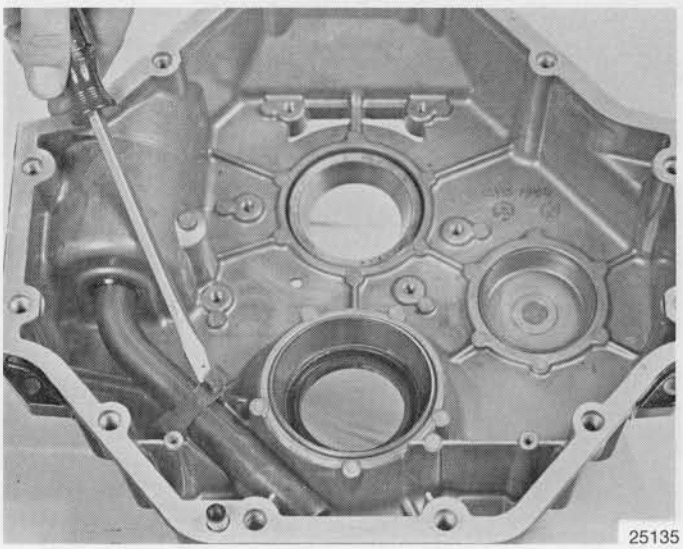
Seals

23. Remove suction pipe seal as follows:



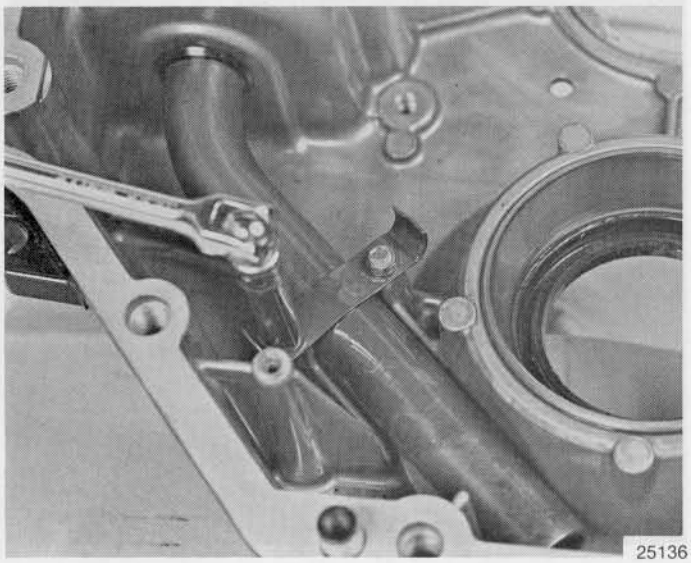
a - Seal

a. Bend tabs up away from screws.

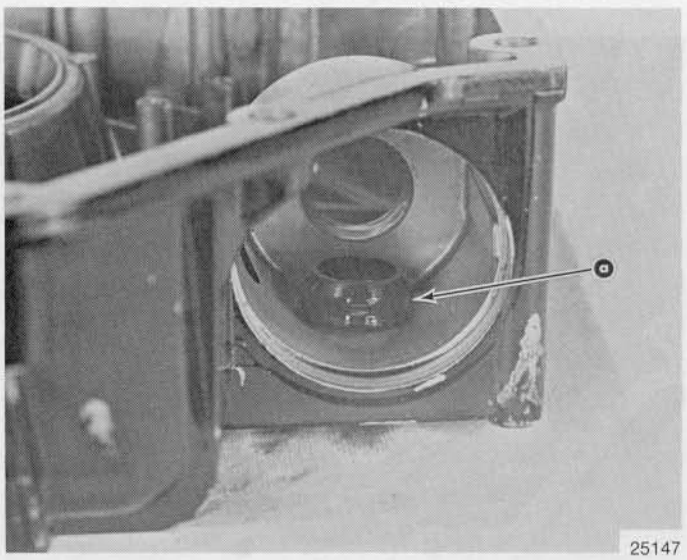


b. Remove screws and hold down plate.

c. Remove suction pipe by pulling downward out of seal.

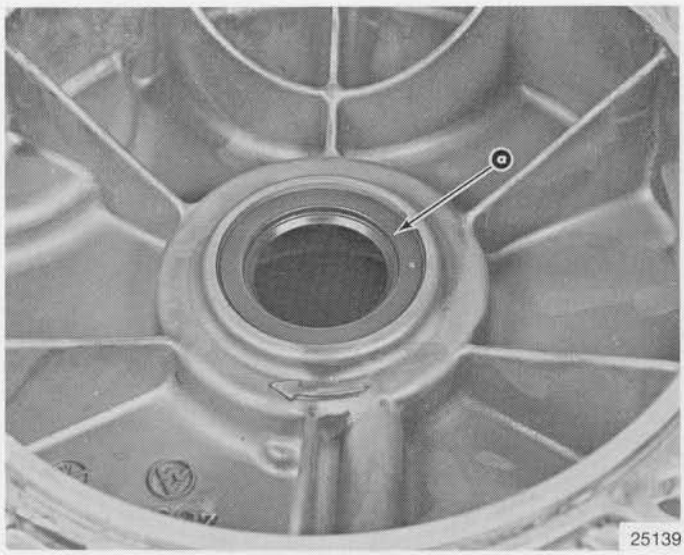


d. Remove seal from top side.



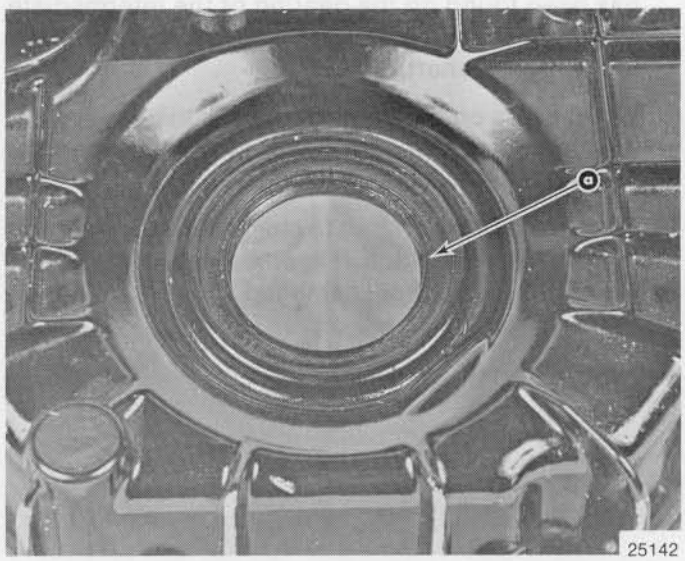
a - Seal

24. Remove input shaft seal using appropriate mandrel.



a - Seal

25. Remove output shaft seal using appropriate mandrel.



a - Seal

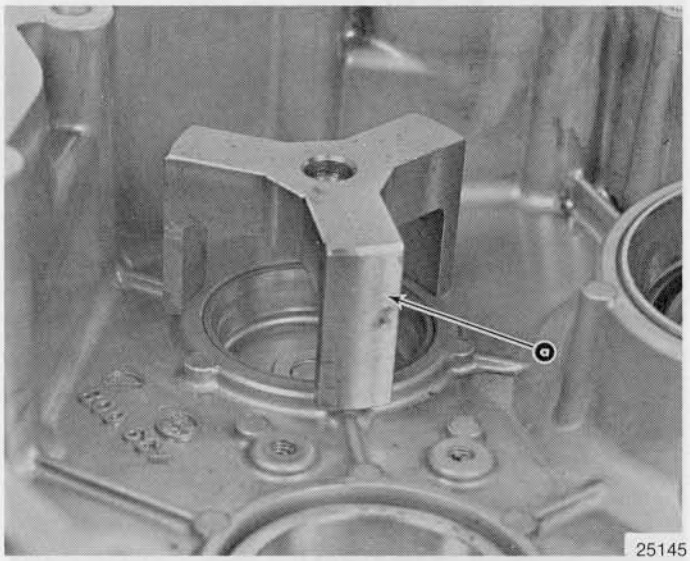
Tapered Roller Bearing Cups

IMPORTANT: Do not remove tapered roller bearing cups unless replacing tapered roller bearings. Bearing and cup must be replaced as a set.

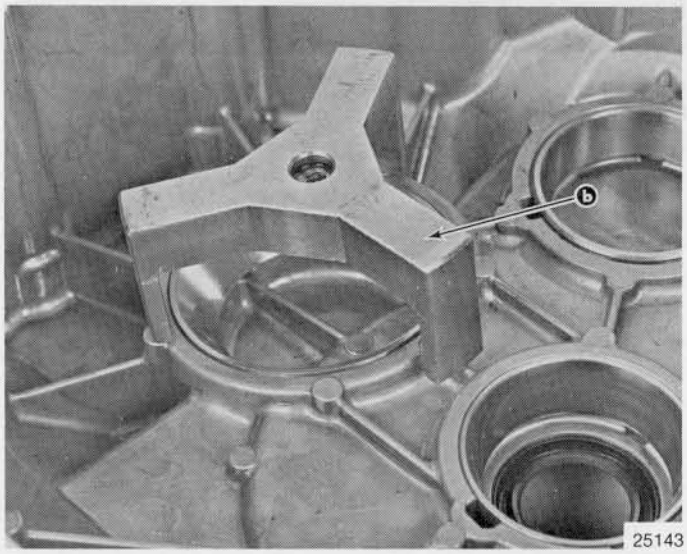
IMPORTANT: Do not mix up shims under cups on the input housing side. Shims are required for adjusting the bearing preload.

26. Pull tapered roller bearing cups from housing use special puller as follows:

    a. Position appropriate puller guide (large diameter or small diameter) over cup as shown.



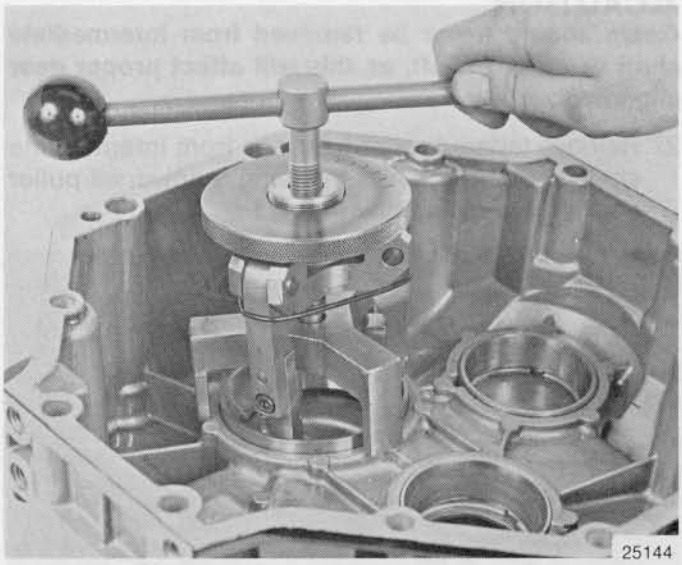
25145



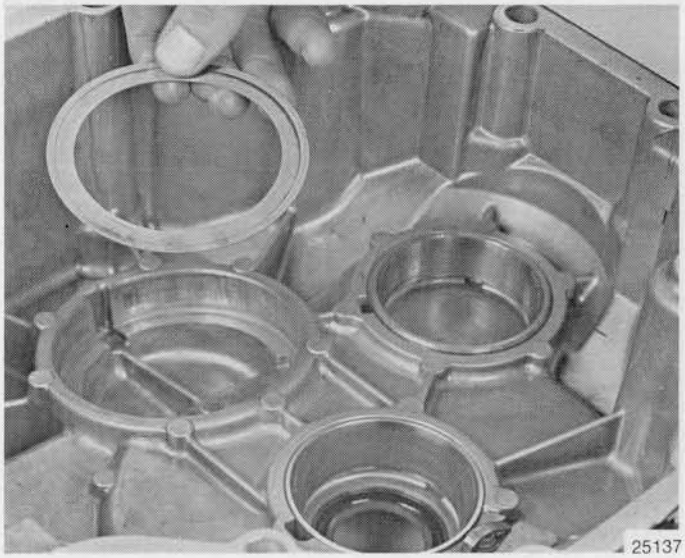
25143

a - Small Diameter Puller Guide
b - Large Diameter Puller Guide

    b. Pull bearing cup from housing using tool as shown.

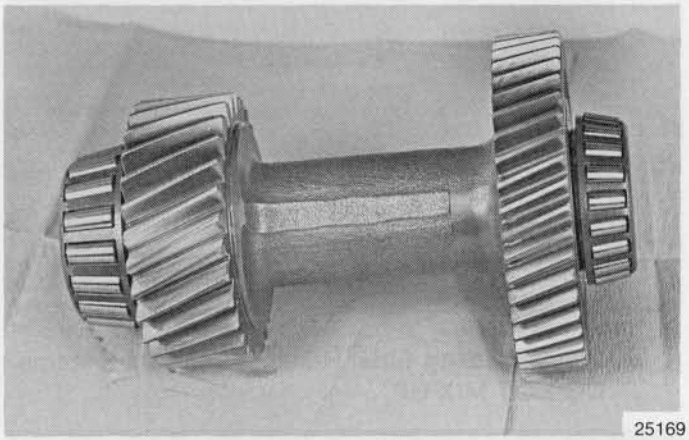

25144

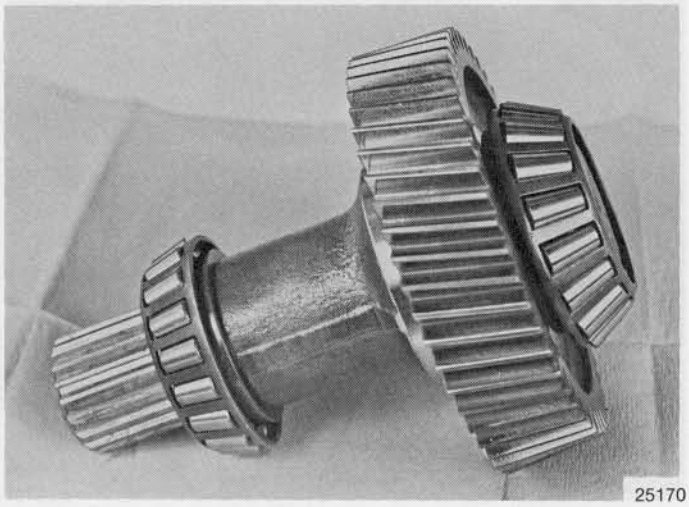
    c. **Input Housing Side:** Remove and retain shims. DO NOT MIX UP.


25137

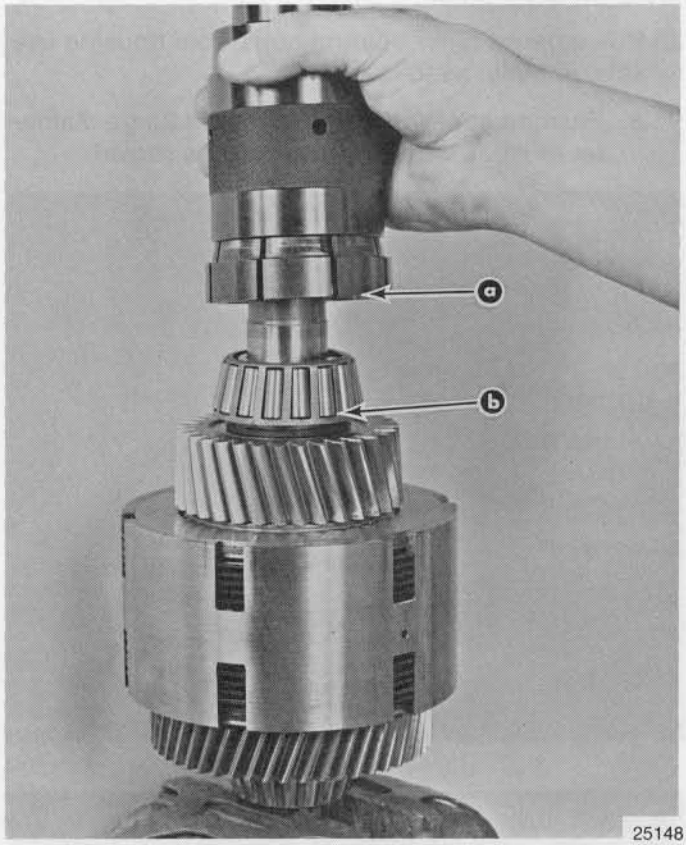
⚠CAUTION
Gears should never be removed from intermediate shaft or output shaft, as this will affect proper gear alignment.

27. Remove tapered roller bearings from intermediate shaft and output shaft by using a universal puller plate and pressing bearings off.


25169


25170

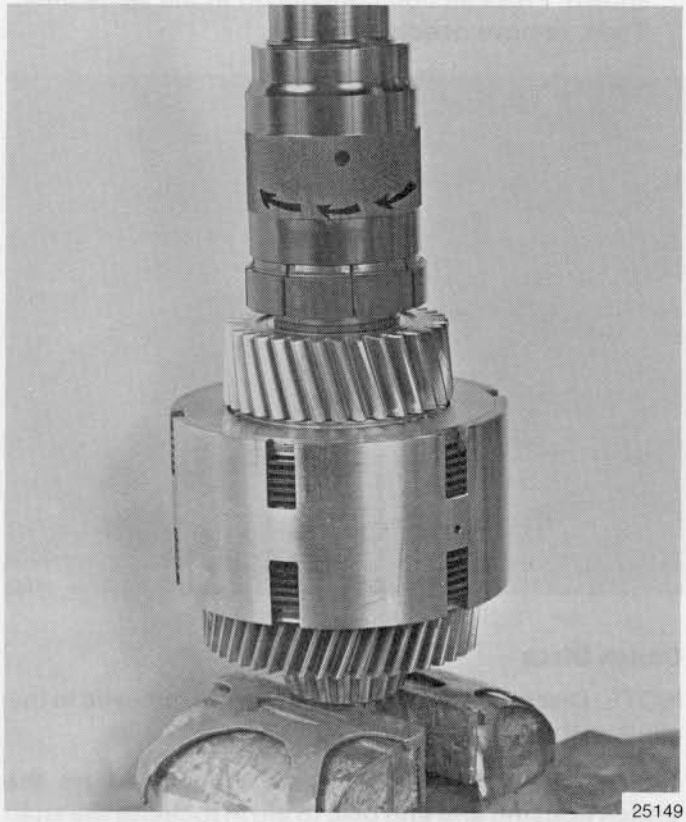
28. Remove tapered roller bearing from splined end of input shaft using special tool as follows:
    a. Place tool over tapered roller bearing. Ensure jaws of tool will be pulling on bottom edge of rollers and NOT on the cage.



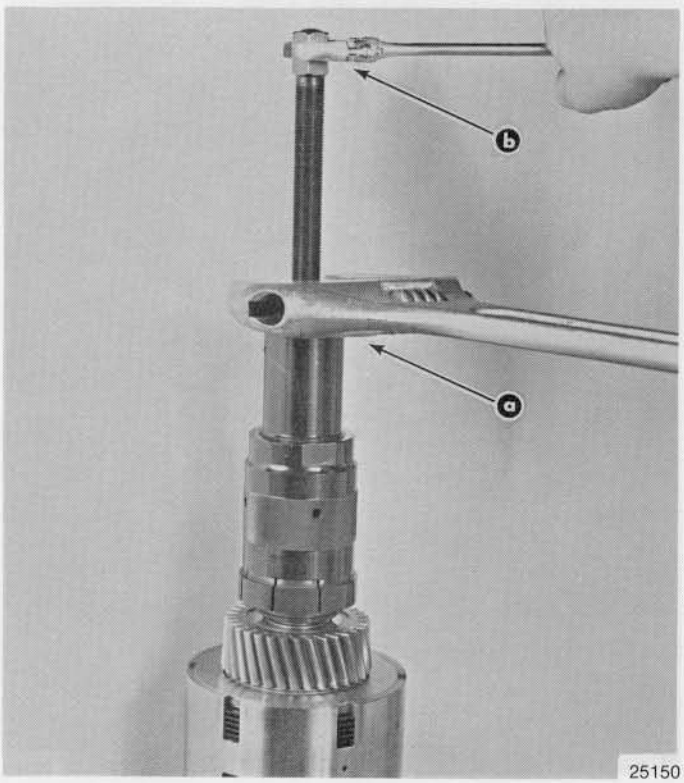
25148

a - Jaws
b - Bottom Edge of Rollers

b Tighten jaws onto bearing by turning on knurled part of tool. Tighten assembly.


25149

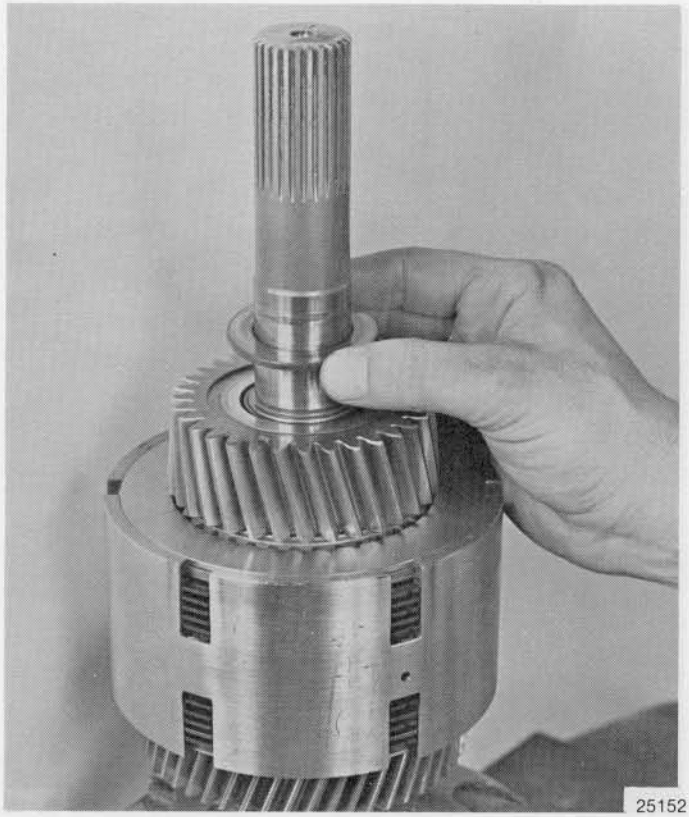
c. Pull tapered roller bearing from shaft using tool as shown.



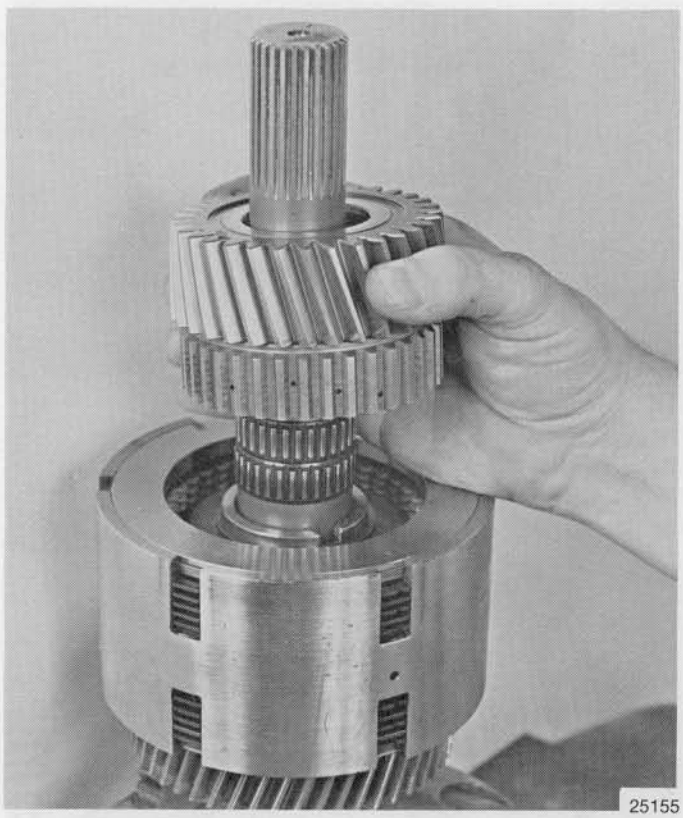
25150

a - Hold Tool Stationary
b - Turn Top Nut

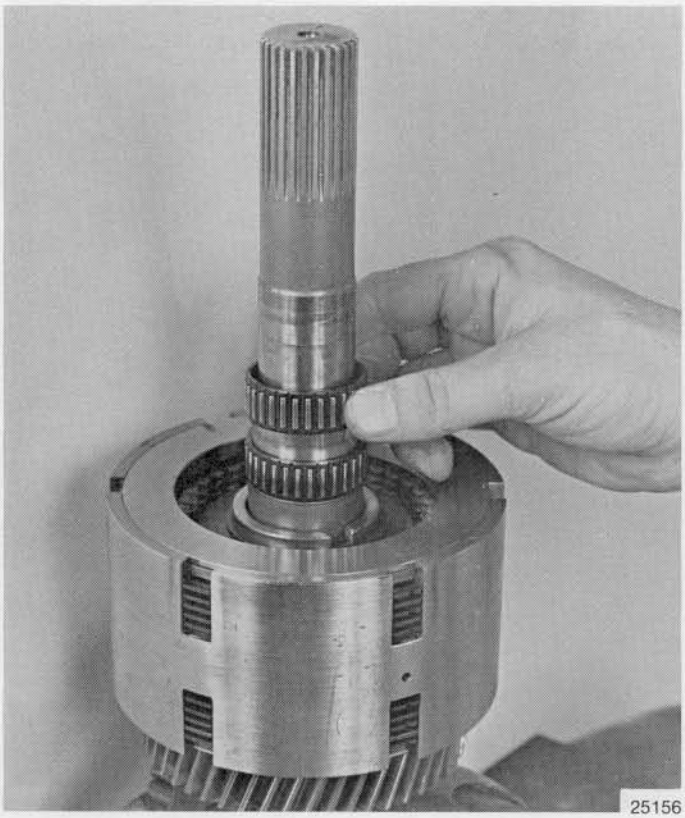
29. Remove butting ring from shaft.


25152

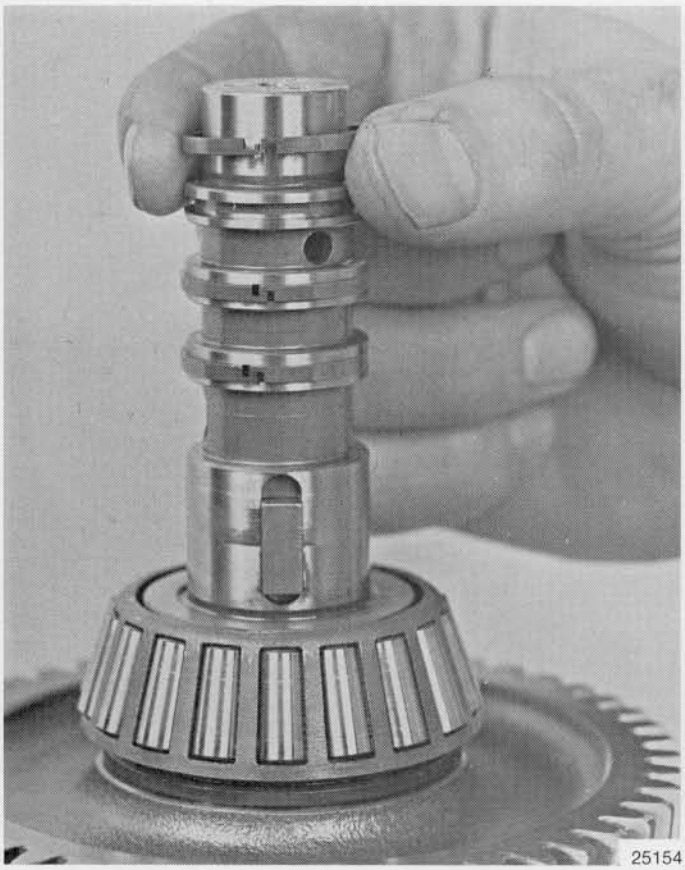
30. Remove gear from clutch assembly.


25155

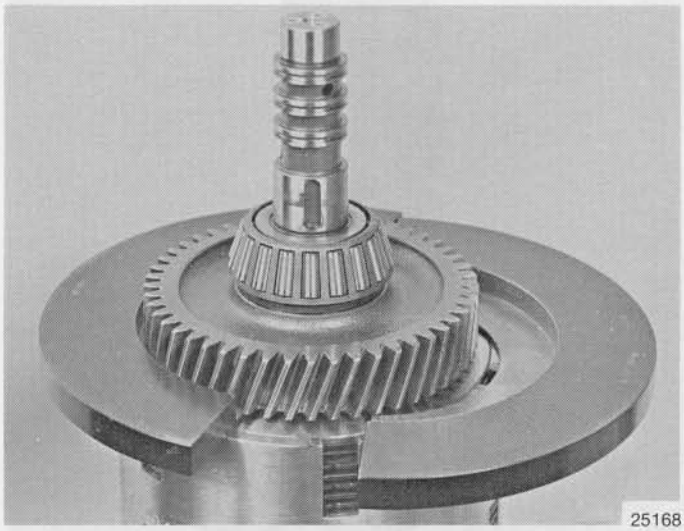
31. Remove needle bearings.


25156

32. Remove piston rings from shaft.


25154

33. Remove tapered roller bearing, butting ring and gear from piston end of shaft using special tool as shown. Press all components off at the same time. Then, remove needle bearings.


25168

Clutch Discs

NOTE: Discs on both sides of clutch are removed in the same manner.

IMPORTANT: Reference marks are placed on the clutch housing and end disc to aid in locating the snap ring opening.

25165

a - Reference Marks

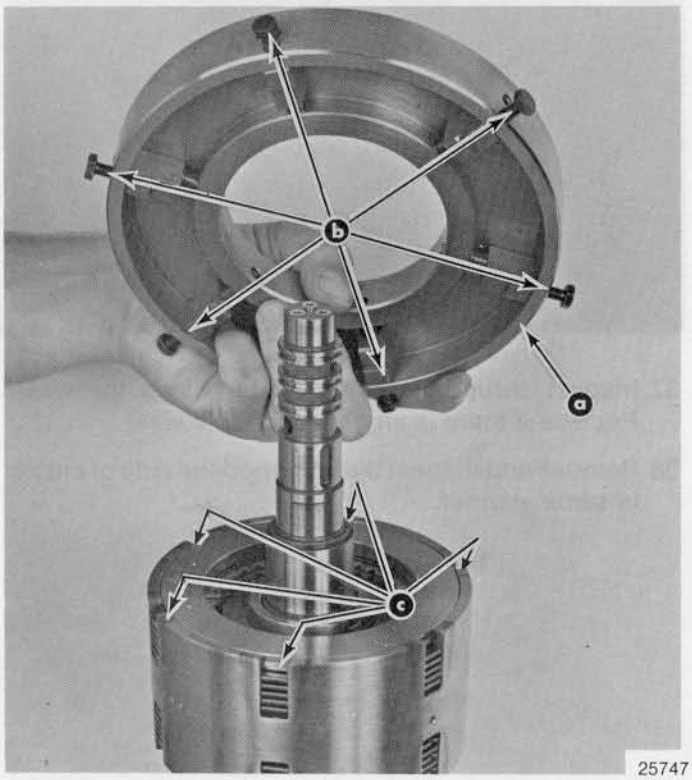
34. Position snap ring compression tool on clutch assembly so that compression screws are centered over slots in clutch housing.

35. Remove end disc and snap ring as follows:

    a. Tighten all compression screws until a slight resistance is felt.

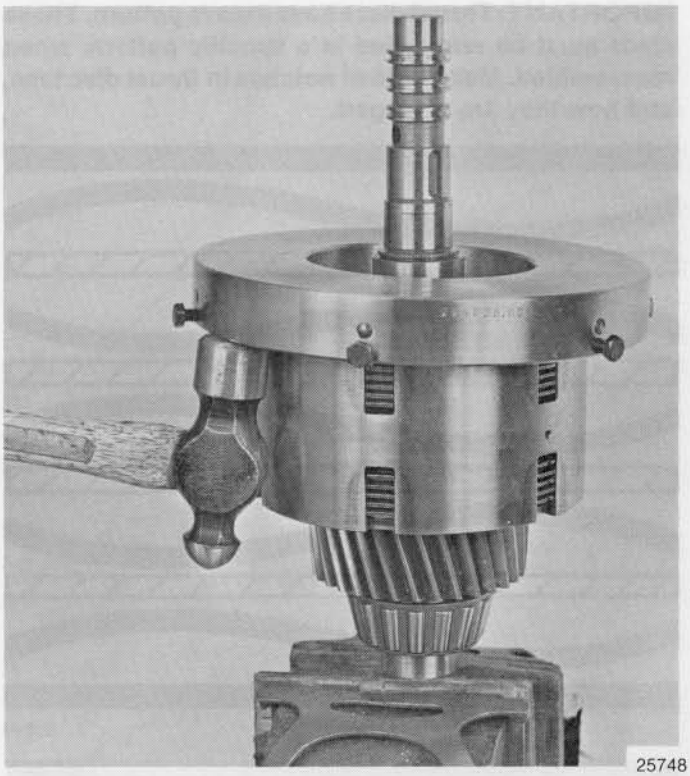
    b. Tighten compression screws evenly (approximately 1/2 turn at a time).

    c. Tap up lightly on bottom edge of compression tool until snap ring pops up and out of groove in clutch housing.

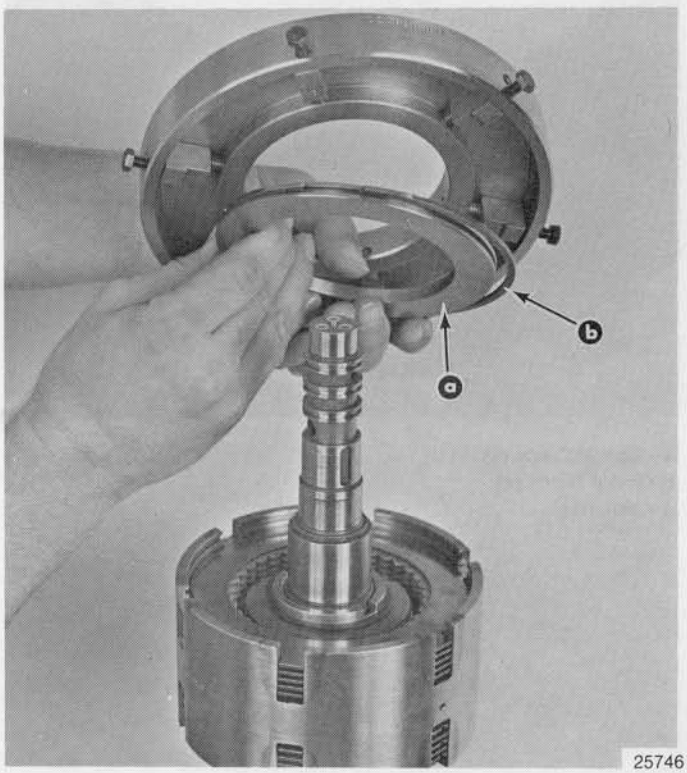


25747

a - Snap Ring Compression Tool
b - Compression Screws (6)
c - Slots


25748

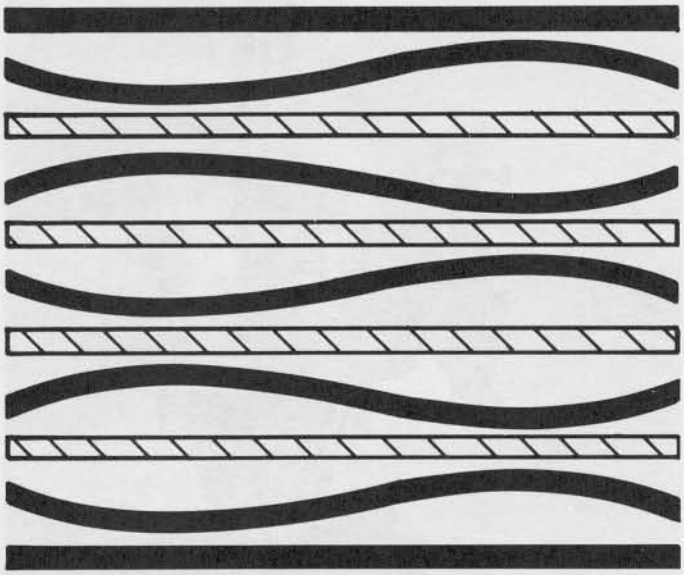
d. Remove end disc and snap ring.



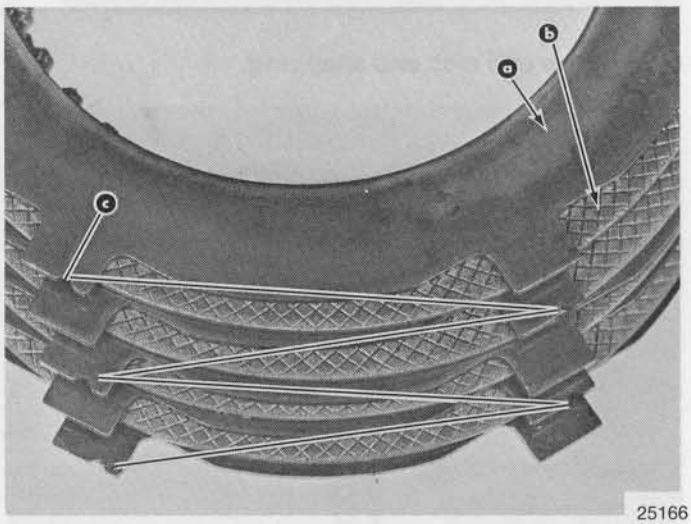
25746

a - End Disc
b - Snap Ring

IMPORTANT: Thrust discs have a wave pattern. These discs must be reinstalled in a specific pattern, when reassembled. Make note of notches in thrust disc tabs, and how they are arranged.



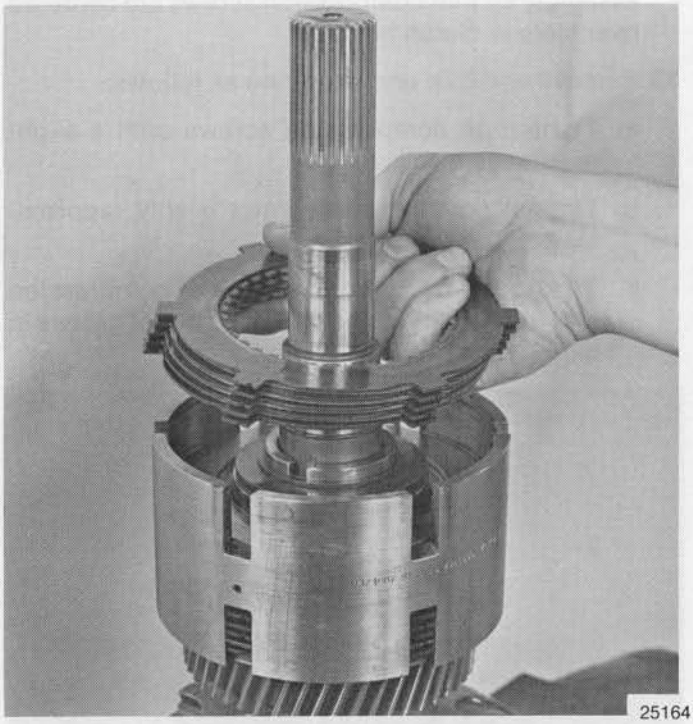
50248



25166

a - Thrust Discs (5)
b - Inner Discs (4)
c - Notches

36. Remove discs.



25164

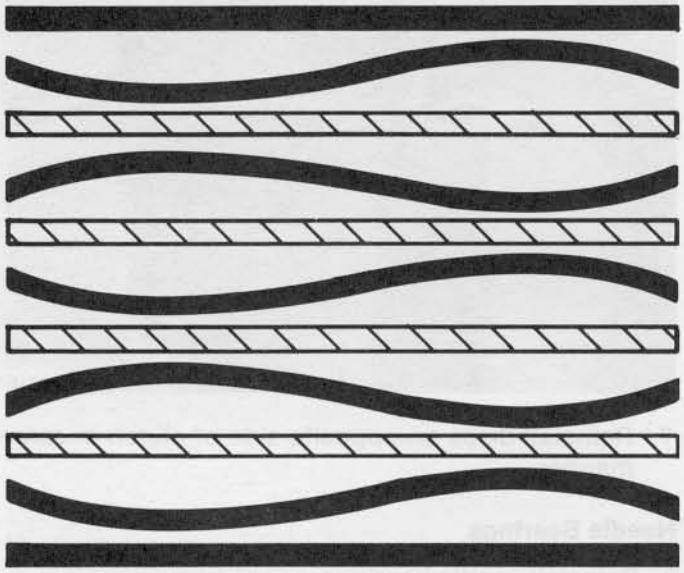
37. Inspect thrust discs and inner discs for wear. Replace if there is any questionable wear.

38. Remove and inspect disc on opposite side of clutch in same manner.

REASSEMBLY

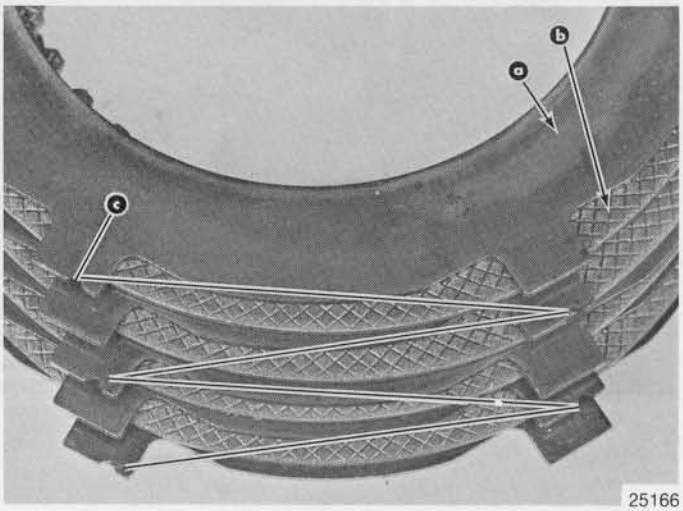
Clutch Discs

IMPORTANT: Thrust discs have a wave pattern. These discs must be reinstalled in a specific manner as explained following.



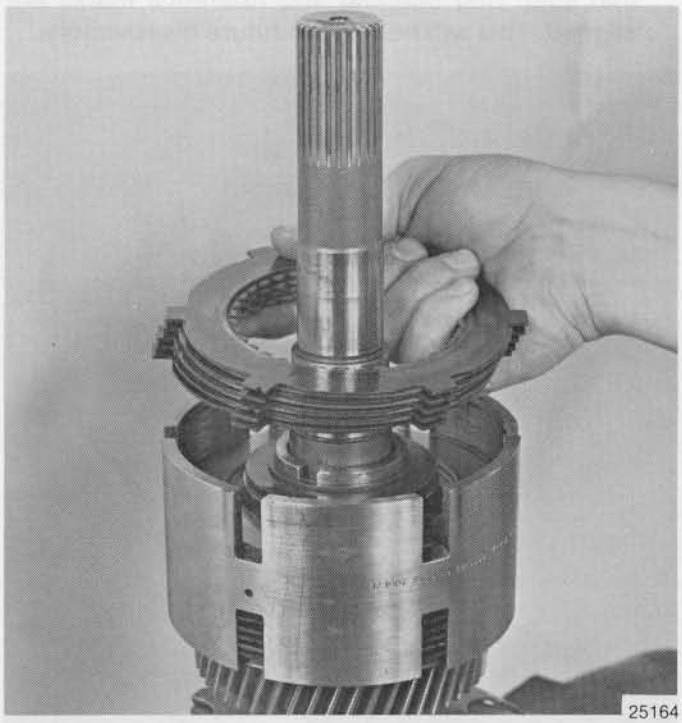
50248

1. Arrange thrust discs and inner discs as shown. Ensure notches on thrust disc tabs are aligned as shown.



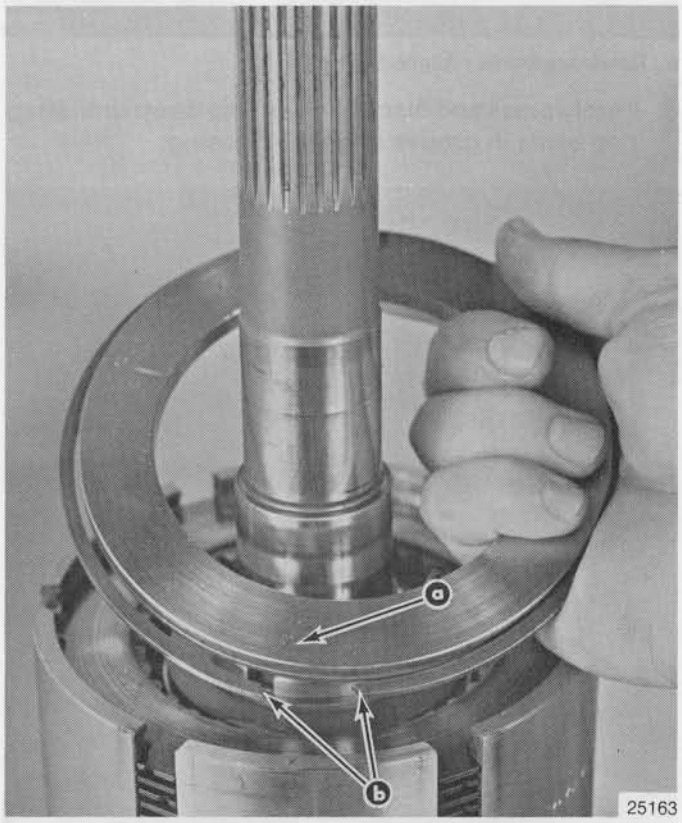
25166

2. Install discs in clutch housing.



25164

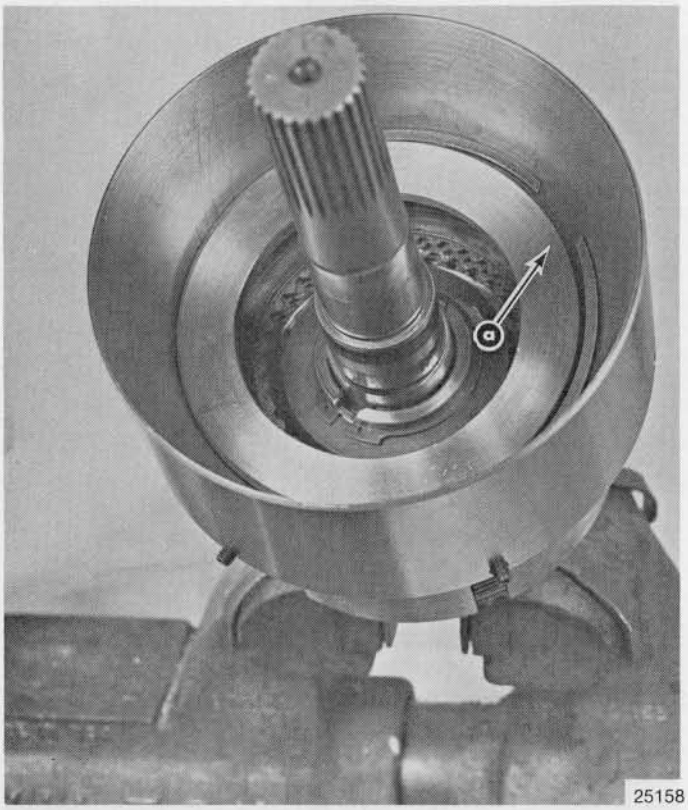
3. Align snap ring opening with reference marks on end disc and clutch housing.



25163

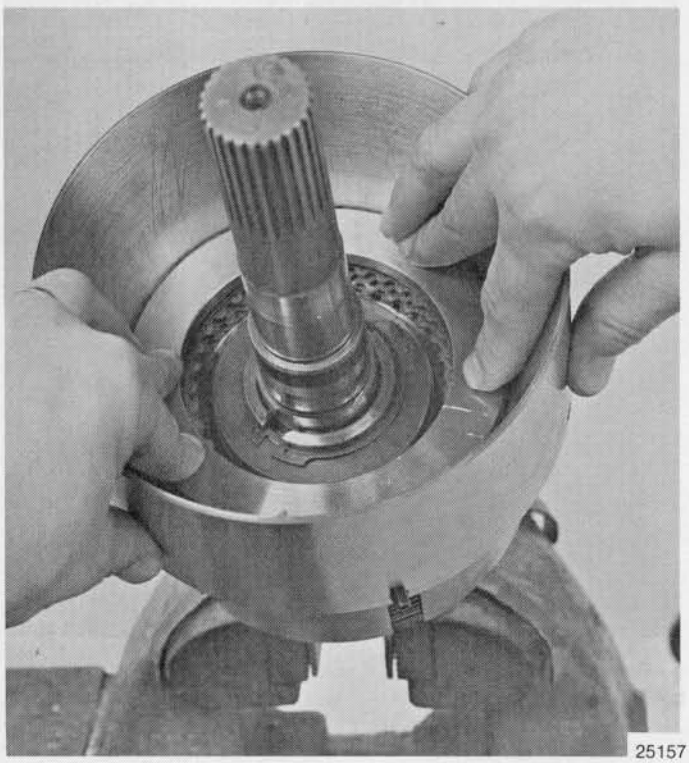
a - Reference Mark
b - Snap Ring Opening

4. Position end disc and snap ring into funnel. Be sure that snap ring opening and reference marks are aligned. This will help aid in future disassembly.

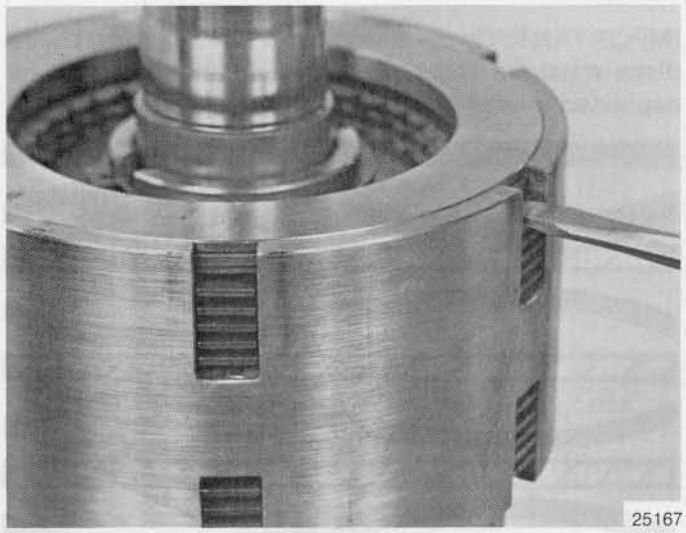


a - Reference Marks - Aligned

5. Firmly press end disc and snap ring down until snap ring seats in groove in clutch housing.



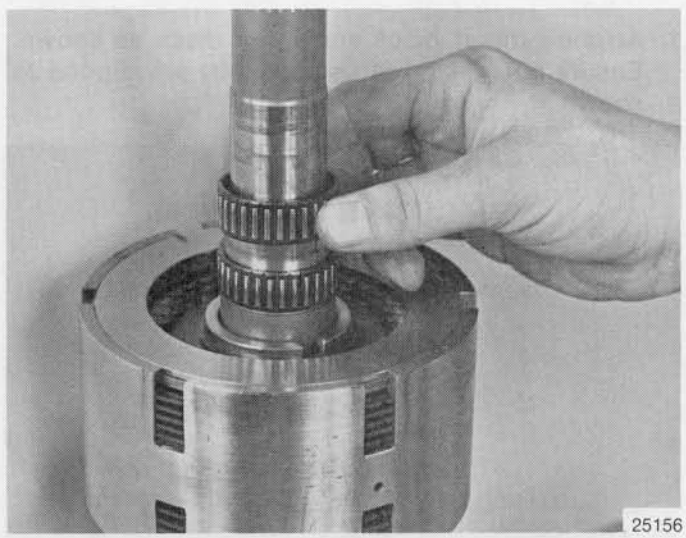
6. Double check that snap ring has been properly seated by prying up lighty on end disc.



7. Reinstall discs on opposite side of clutch in same manner.

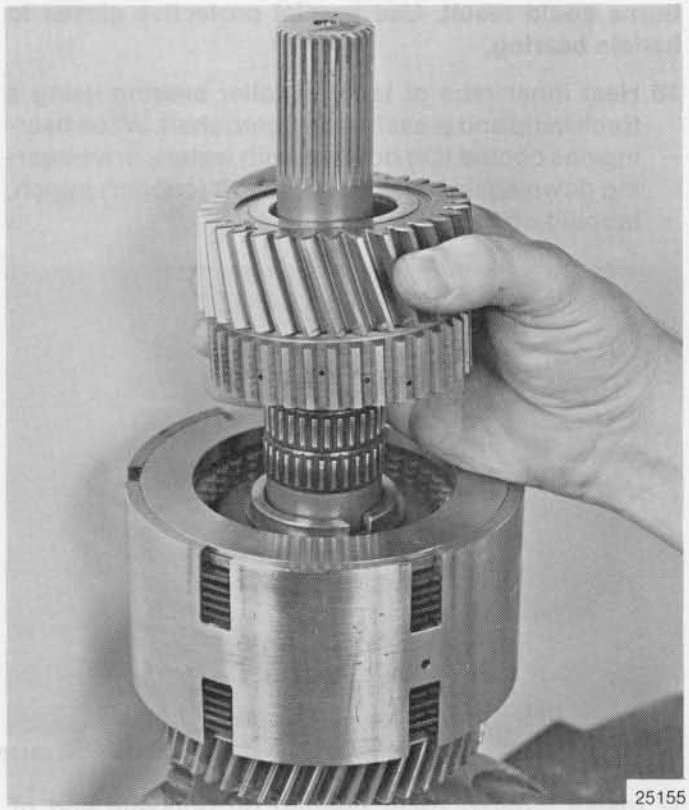
Needle Bearings

8. Reinstall needle bearings.

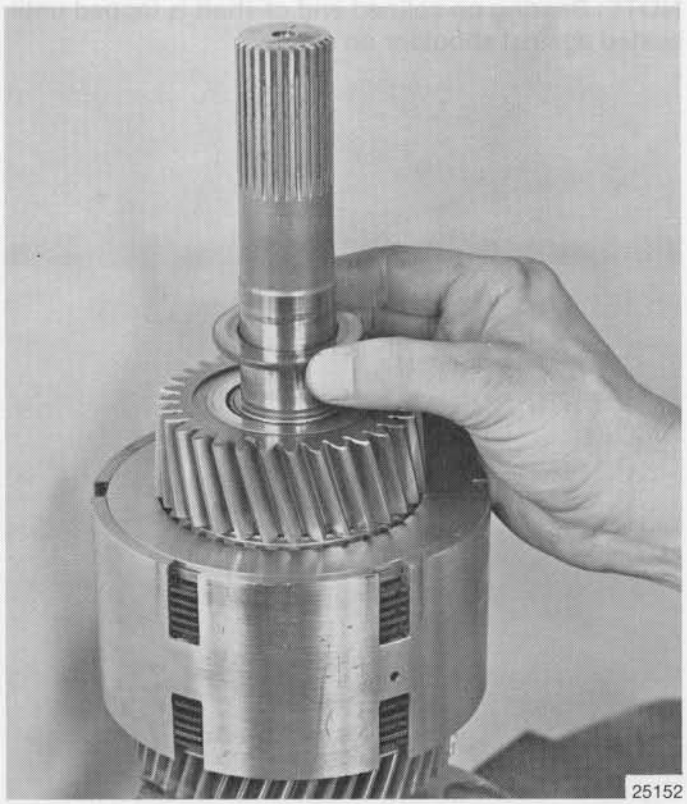


Gear Assembly

9. Reinstall gear assembly. Twist gear assembly from side to side to allow splines to engage with inner discs. Ensure all inner discs are engaged with splines by observing through slots in clutch housing.



10. Reinstall butting ring.

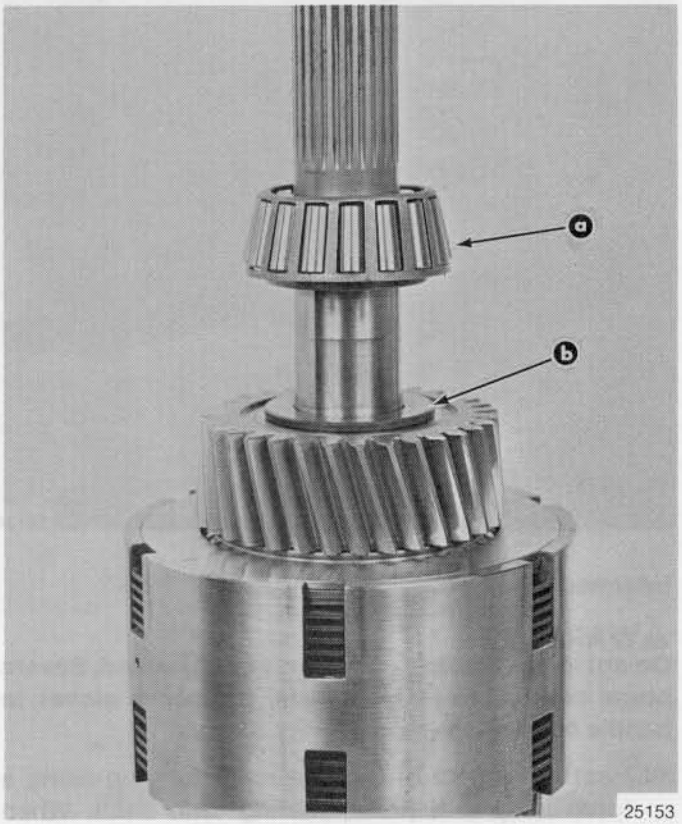


Tapered Roller Bearing

⚠CAUTION

Do not touch bearing once it has been heated. Severe burns could result. Use special protective gloves to handle bearing.

11. Heat inner race of tapered roller bearing using a torch lamp and press bearing onto shaft. When bearing has cooled down (Do not cool with water), tap bearing **carefully** down to ensure proper seating against butting ring, using a soft (copper) punch **Tap on inner race only.**

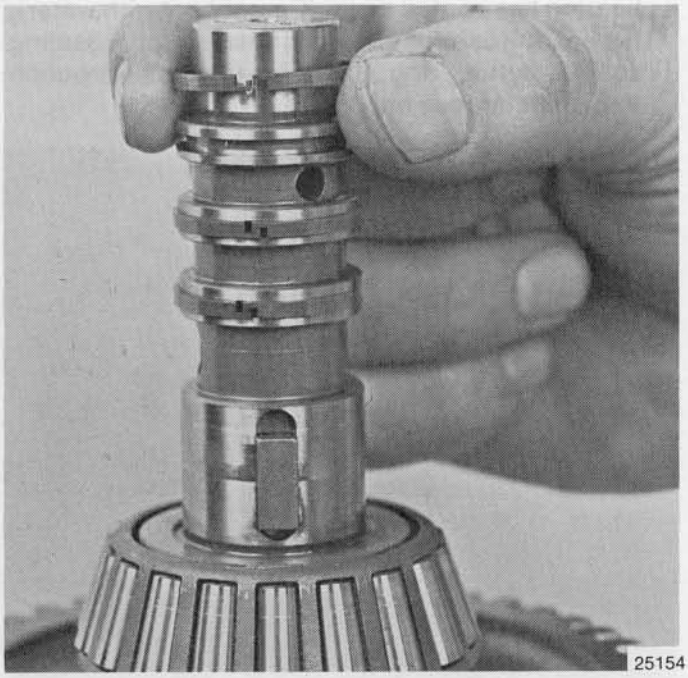


a - Tapered Roller Bearing
b - Butting Ring

12. Install components on opposite side of clutch assembly in same manner.

⚠CAUTION
Use care in reinstalling piston rings on input shaft. Piston rings are brittle and may snap if spread too far open.

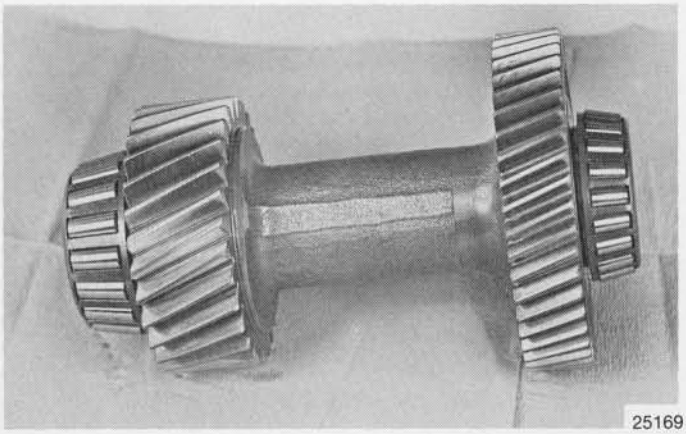
13. Reinstall piston rings on input shaft. Ensure ends of rings are coupled as shown. Then, position rings so that ends are staggered so no two are aligned.


25154

Intermediate Shaft

⚠WARNING
Do not touch bearing once it has been heated. Severe burns could result. Use special protective gloves to handle bearing.

14. Heat inner race of tapered roller bearing using a torch lamp and press bearing onto shaft. When bearing has cooled down (Do not cool with water), tap bearing **carefully** down to ensure proper seating against gear, using a soft (copper) punch. **Tap on inner race only.**

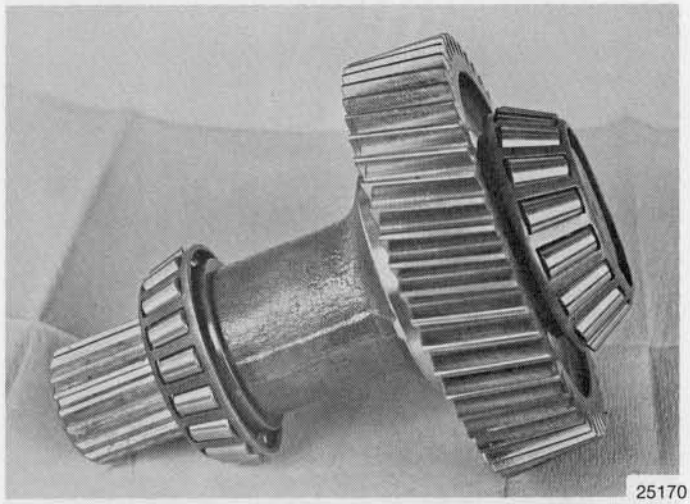

25169

15. Install tapered roller bearing on opposite end of shaft in the same manner.

Output Shaft

⚠WARNING
Do not touch bearing once it has been heated. Severe burns could result. Use special protective gloves to handle bearing.

16. Heat inner race of tapered roller bearing using a torch lamp and press bearing onto shaft. When bearing has cooled (Do not cool with water), drive bearing down against gear using a soft (copper) punch, tapping on inner race only.


25170

17. Install tapered roller bearing on opposite end of shaft in the same manner.

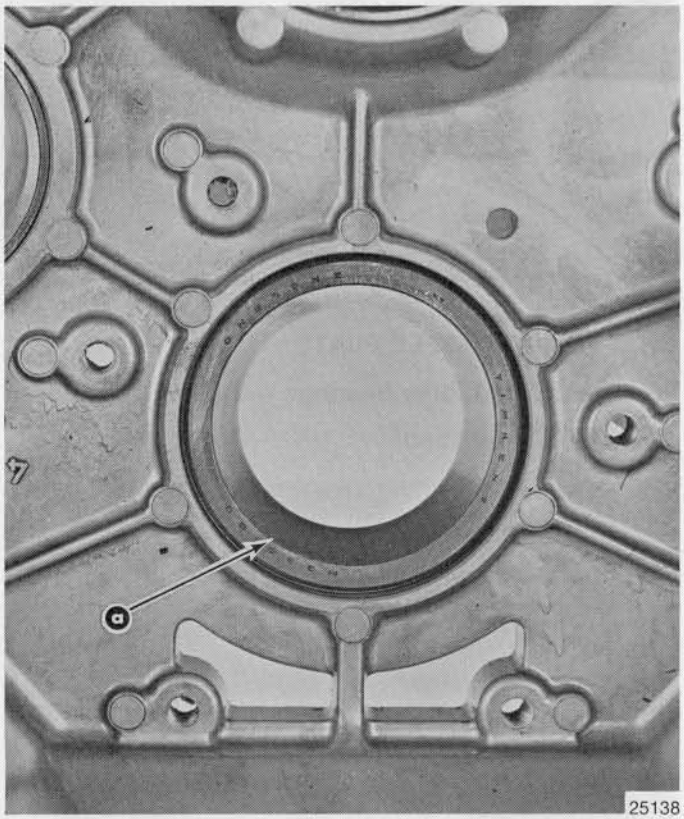
NOTE: Bearing on splined end of shaft is tapped until seated against shoulder on shaft.

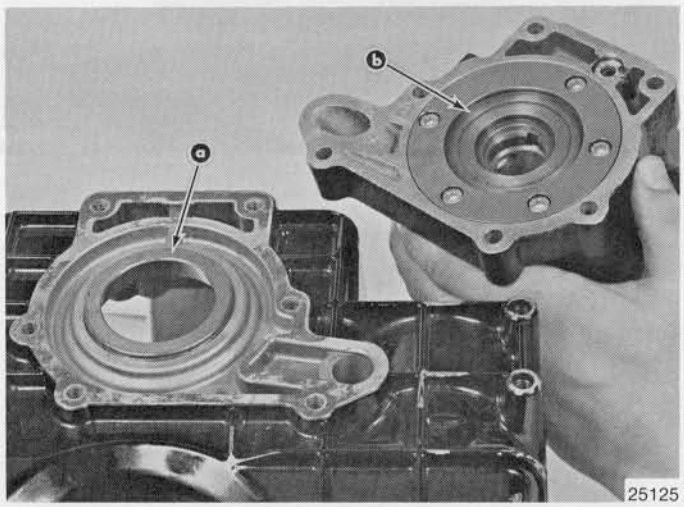
Preassembly of Output Half of Housing

IMPORTANT: If tapered roller bearing cups were removed, ensure output shaft seal IS NOT in place, as it will be necessary to heat housing prior to installing bearing cups.

IMPORTANT: The tapered roller bearing cup on the input shaft (control block end) is properly positioned by bottoming out on the face of the control block assembly. It will be necessary to temporarily install control block to install this tapered roller bearing cup.

18. Temporarily install control block on outer housing. Tighten bolts securely.

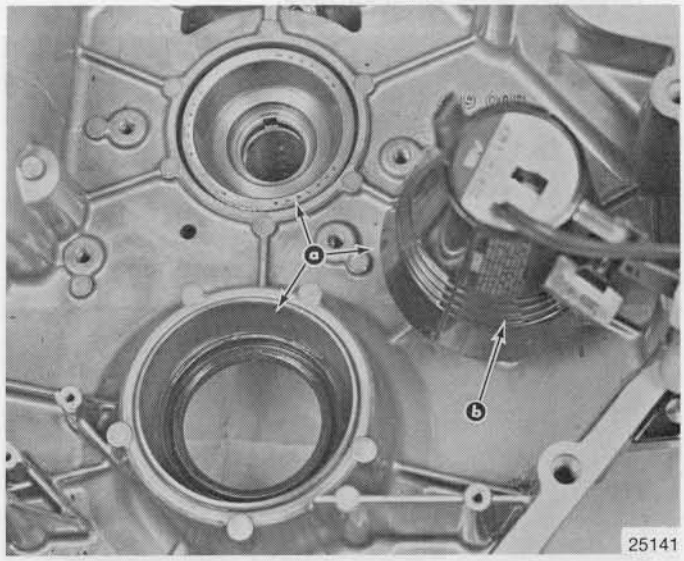




a - Input Shaft Bearing Cup
b - Control Block Face

⚠WARNING
Use care in handling housing, once it is heated with torch lamp. Severe burns could result. Use special protective gloves when handling housing.

19. Heat bearing bores of housing using a torch lamp and install bearing cups using a suitable mandrel.



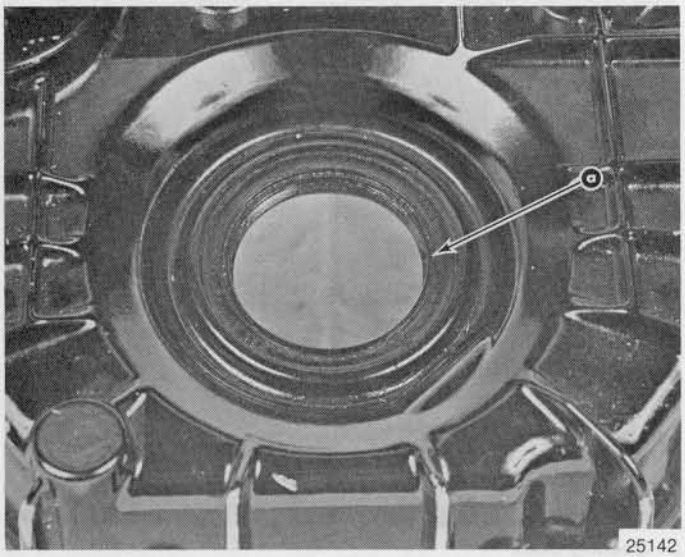
a - Bearing Cups
b - Torch Lamp

20. Allow housing to cool (Do not cool with water) and then tap bearing cup with suitable mandrel to ensure it is properly seated.
21. Remove control block assembly.

Loctite around seal

OUTPUT SHAFT SEAL

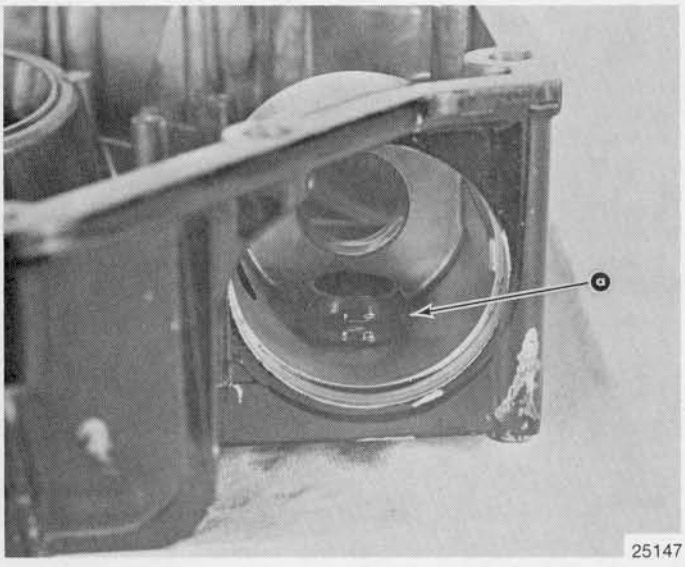
22. **If bearing were not replaced and no shimming is required,** push new seal onto special mandrel. Ensure seal will be positioned with lip of seal facing inward. Drive seal uniformly into bore of housing to the point that it is countersunk .040 in. (1mm) with reference to housing surface.



a - Seal

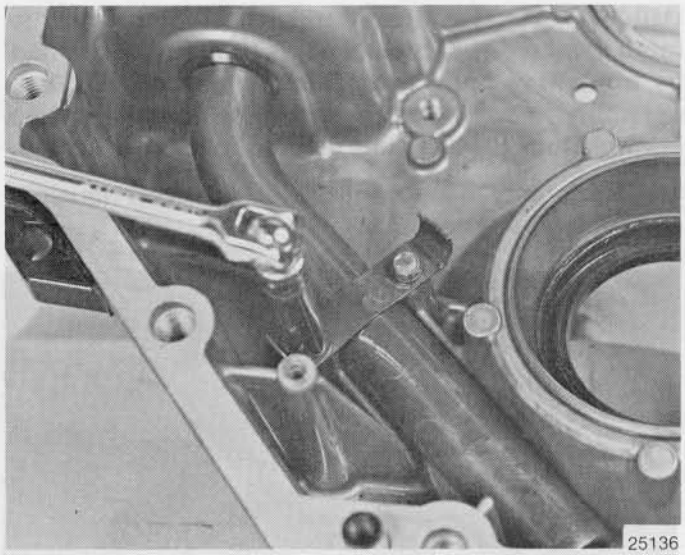
SUCTION PIPE

23. Reinstall suction pipe seal in bottom of oil filter bore. Coat seal with ATF.



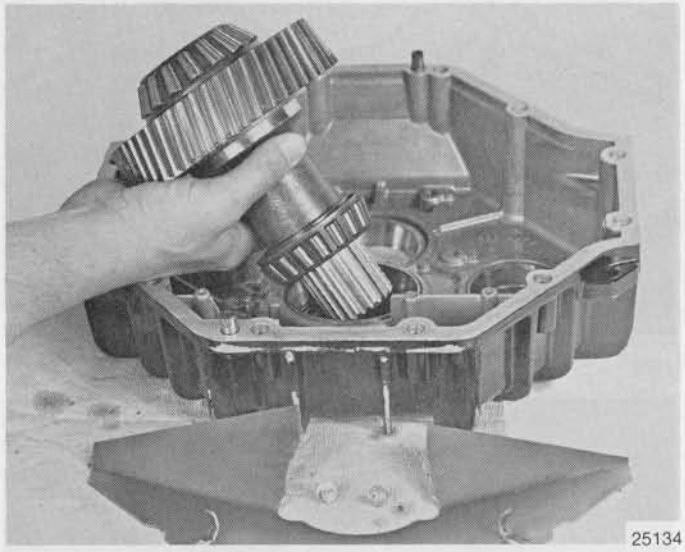
a - Seal

24. Reinstall suction pipe. Place one drop of Loctite Type "A" on screw threads. Then, secure suction pipe down with retainer plate. Tighten screws securely.
25. Bend tabs down over screws.

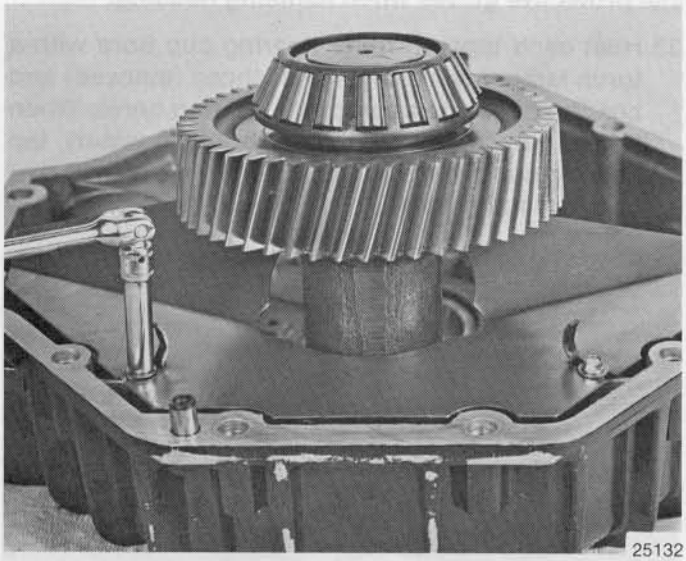


SHAFTS AND BAFFLE PLATE

26. Coat tapered roller bearings with ATF.
27. Install output shaft.

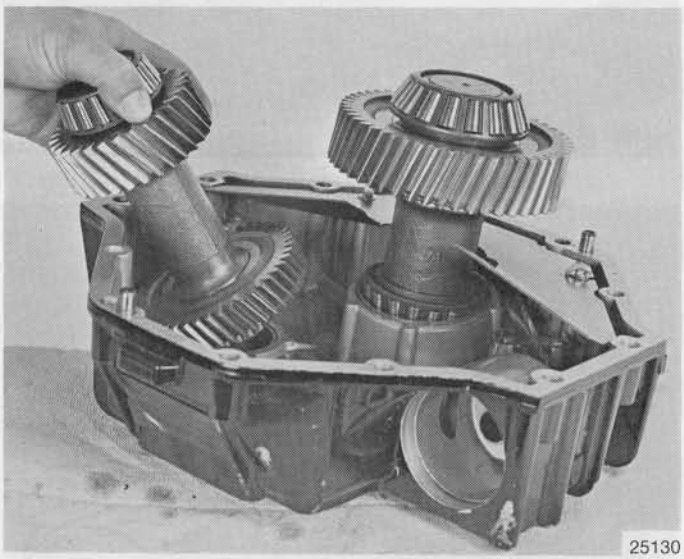


28. Install baffle plate. Apply one drop of Loctite Type "A" to screws. Tighten screws securely and bend tabs down over screws.



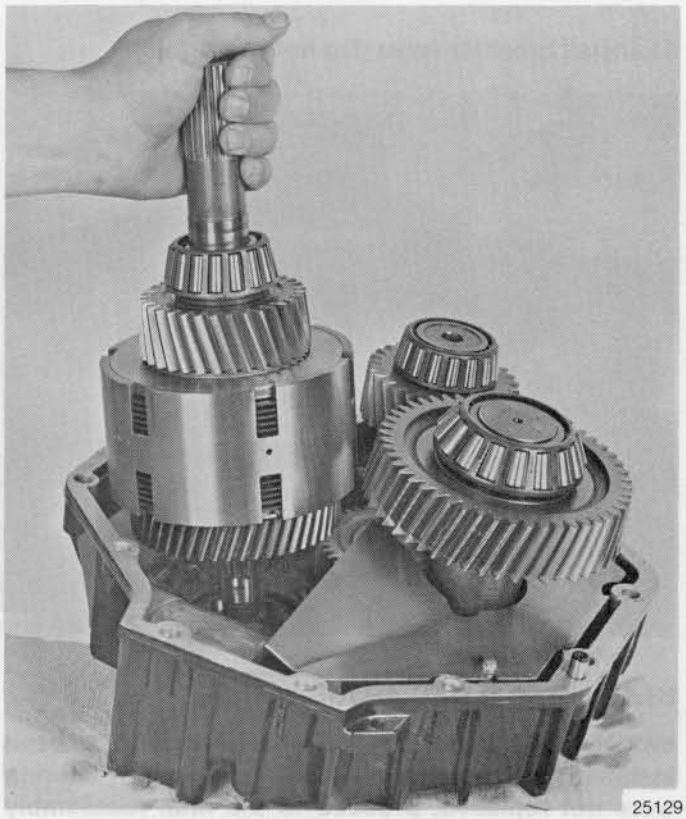
25132

29. Install intermediate shaft.

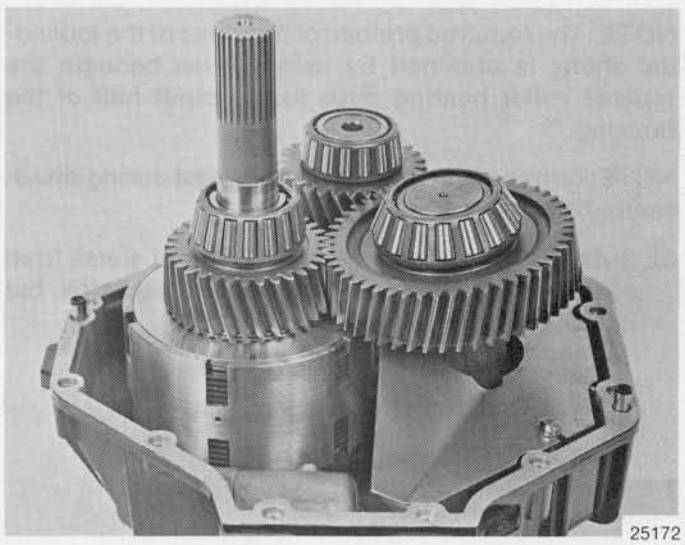


25130

30. Install input shaft. Ensure all gears mesh as shown.



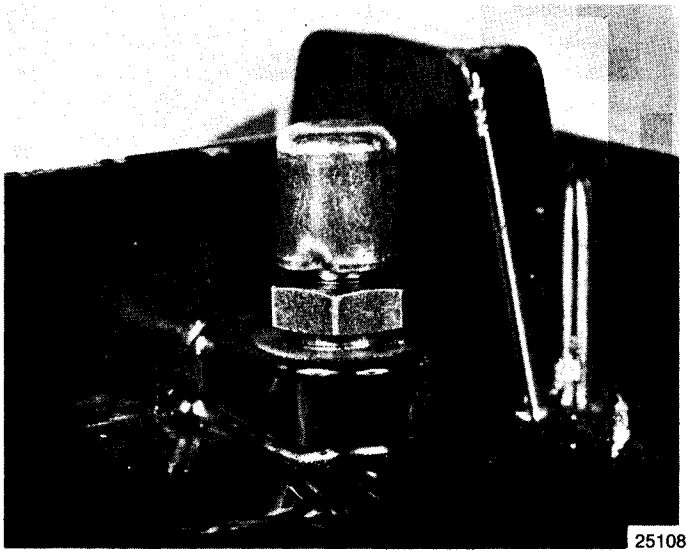
25129



25172

Preassembly of Input Half of Housing

31. Install breather valve (Do not overtighten).


25108

BEARING PRELOAD ADJUSTMENT

IMPORTANT: If new tapered roller bearings have been installed, the preload must be readjusted. If bearing were not replaced, proceed to the final reassembly section.

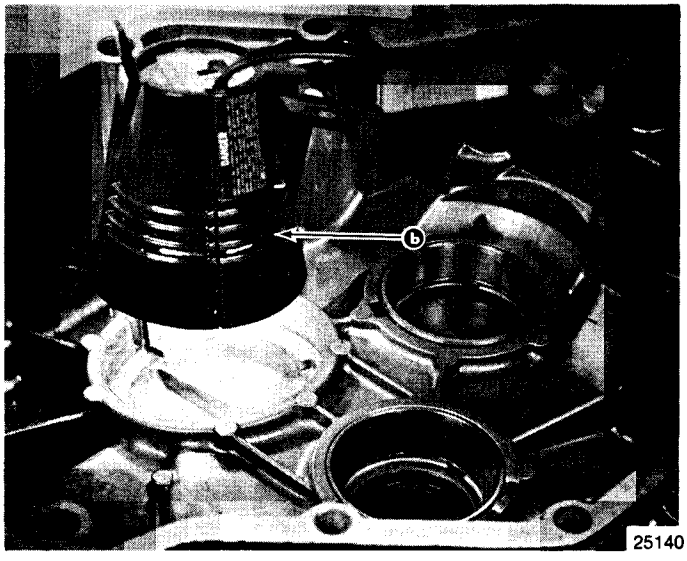
NOTE: The required preload of bearings of the individual shafts is obtained by using shims beneath the tapered roller bearing cups in the input half of the housing.

NOTE: Shims which have been removed during disassembly may be reused.

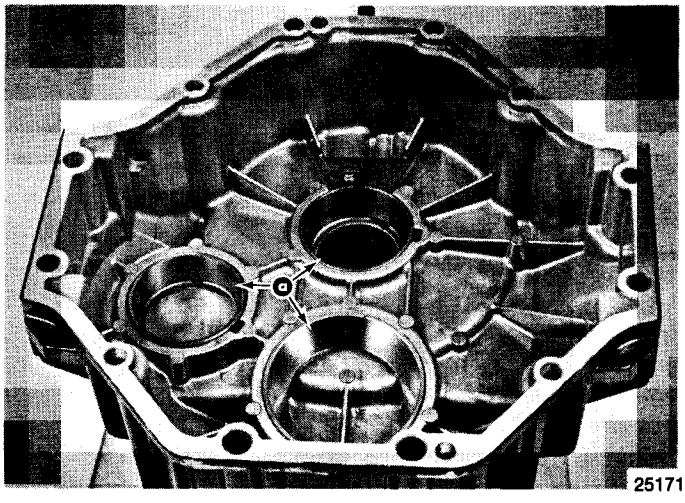
32. Subtract approximately .008 (.2mm) of shims from each bearing cup bore. Remove and set aside, but do not mix up.

⚠WARNING
Use care in handling housing once it has been heated with a torch lamp. Severe burns could result. Use special protective gloves when handling housing.

33. Heat each tapered roller bearing cup bore with a torch lamp. Insert shims (less those removed) and bearing cups into appropriate bearing bores. When housing has cooled (Do not cool with water), tap bearing cups with a suitable mandrel to ensure that cups are fully seated.



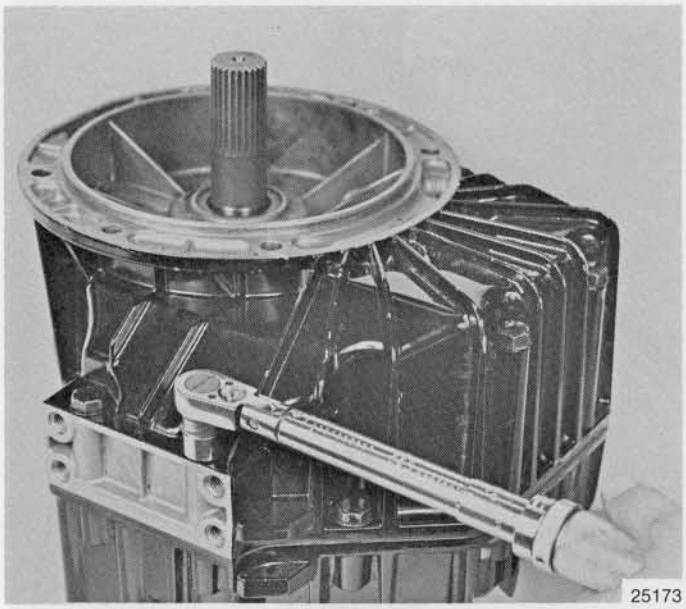
25140



25171

a - Bearing Cups
b - Torch Lamp

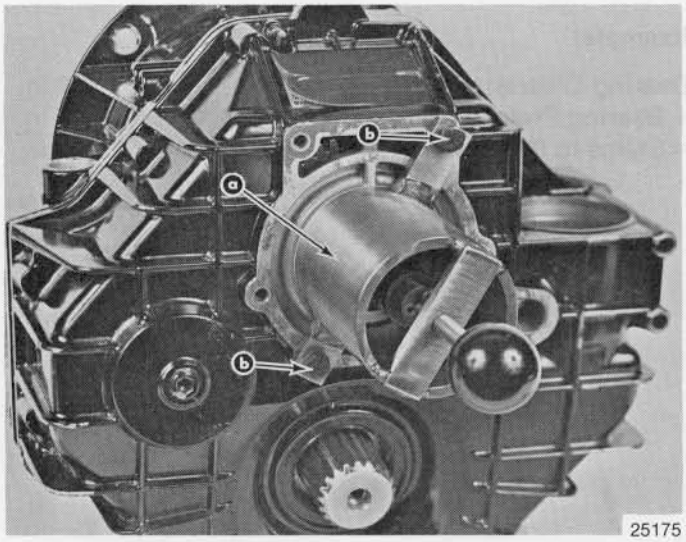
34. Install input half of housing onto output half. Ensure locator pins are in place. Install bolts and lockwashers and torque to 36 lb. ft. (49 N.m).


25173

OUTPUT SHAFT PRELOAD

35. Measure bearing clearance as follows:

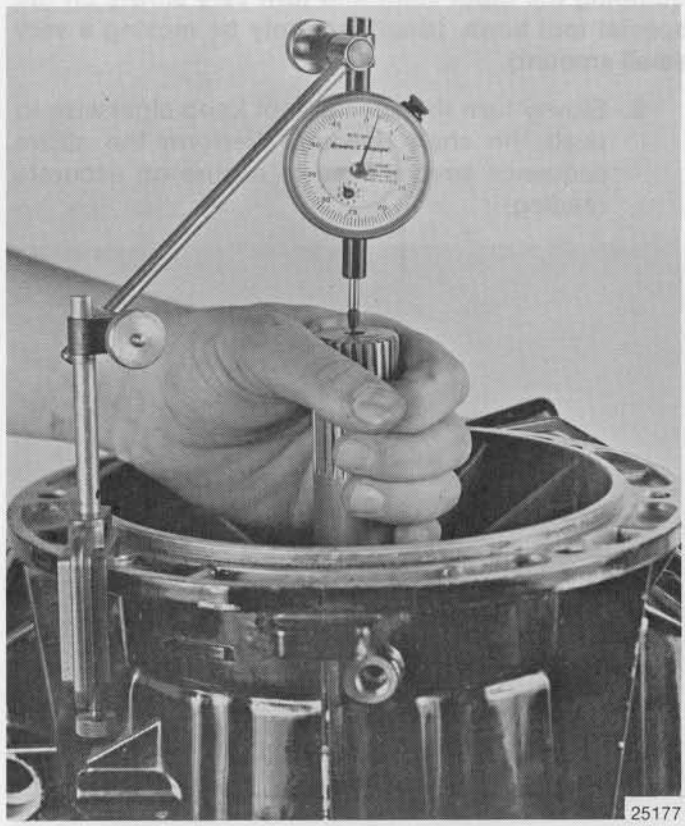
a. Install special tool as shown. Tighten hold down bolts securely.



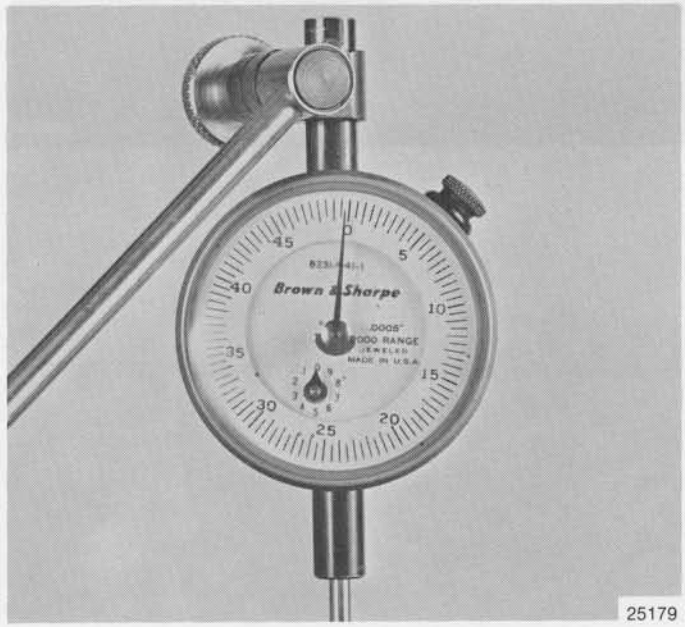
25175

a - Special Tool
b - Hold Down Bolts

b. Mount dial indicator on input shaft. Turn input shaft several time to seat bearing.


25177

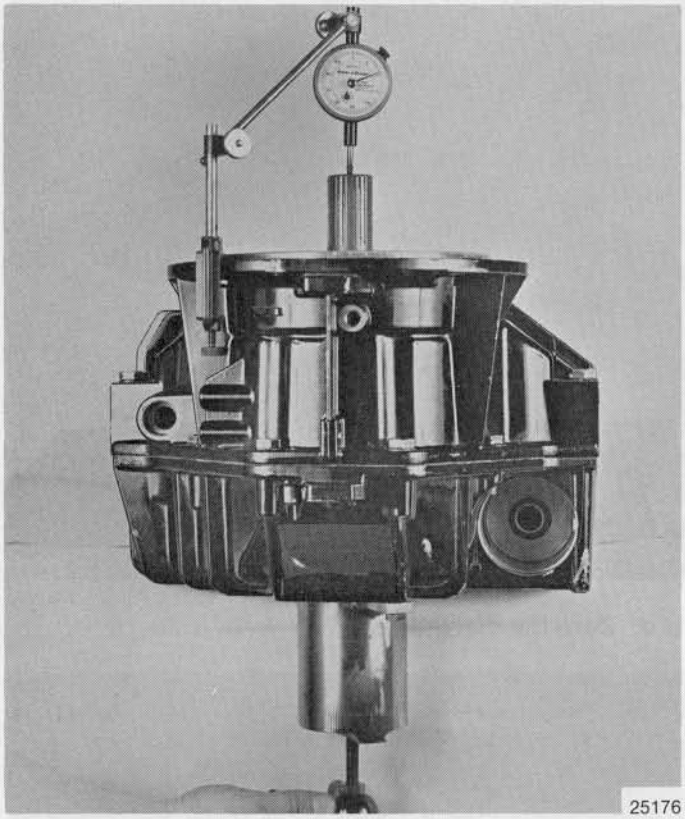
c. Zero the dial indicator.



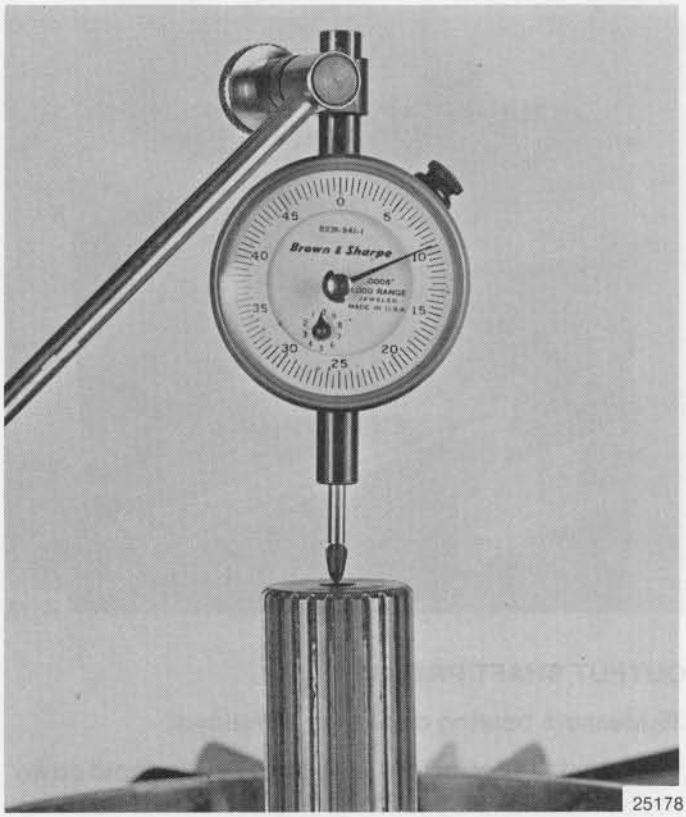
25179

IMPORTANT: The following step should be done very carefully to obtain the actual bearing clearance. Avoid bumping the input shaft and turn very slowly on the special tool knob. (Shaft will only be moving a very small amount).

d. Slowly turn the special tool knob clockwise to push the shaft upward. (Perform the above sequence several time to ensure on accurate reading).


25176

e. Make note of reading. The bearing clearance measured **PLUS** the preload required is equal to the amount of shim thickness to be **ADDED.**



25178

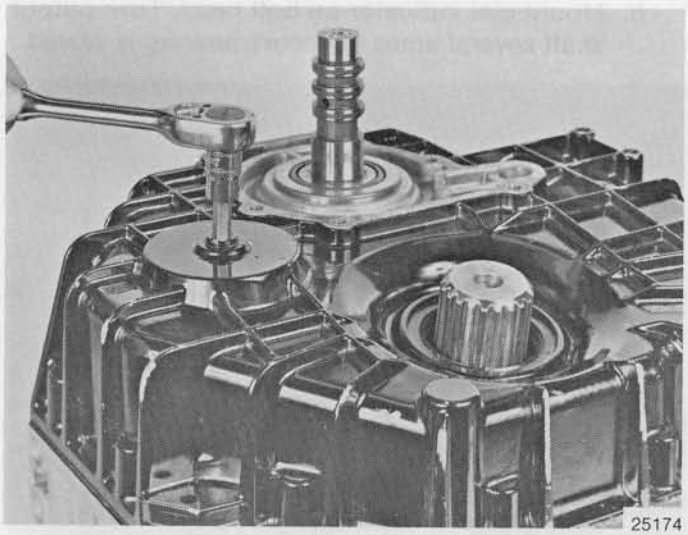
Example:

Bearing Clearances Measured	.009 in.
+ Bearing Preload Required	.004 in.
= Shims to Be Added	.013 in.

INTERMEDIATE SHAFT PRELOAD

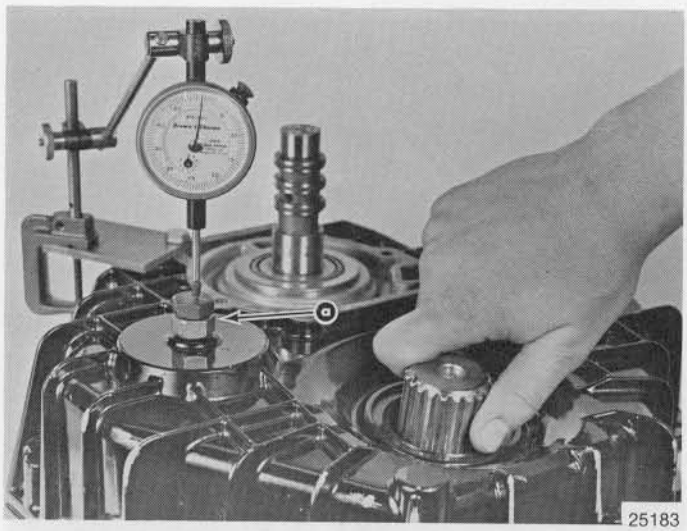
36. Measure bearing clearance as follows:

a. Remove hex plug from housing.


25174

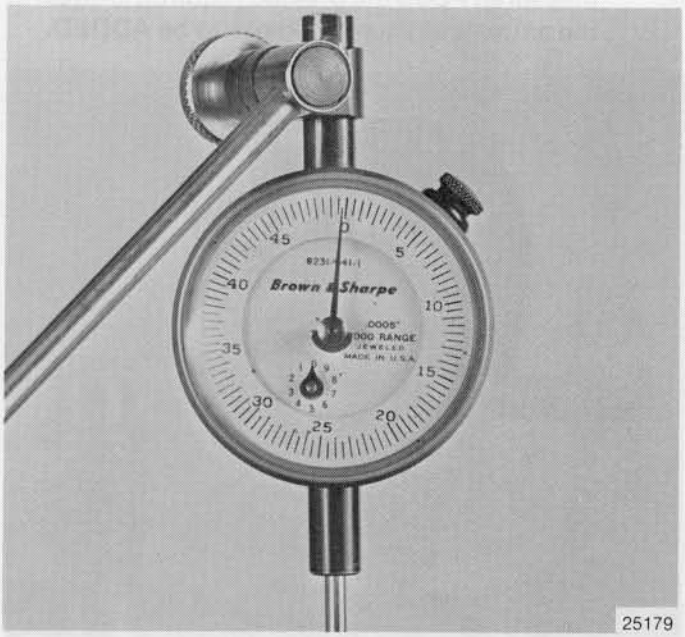
b. Screw special bolt with nut into intermediate shaft and tighten snuggly. Turn nut up until it touches bolt head.

c. Mount dial indicator on bolt head. Turn output shaft several times to ensure bearing is seated.


25183

a - Special Bolt With Nut

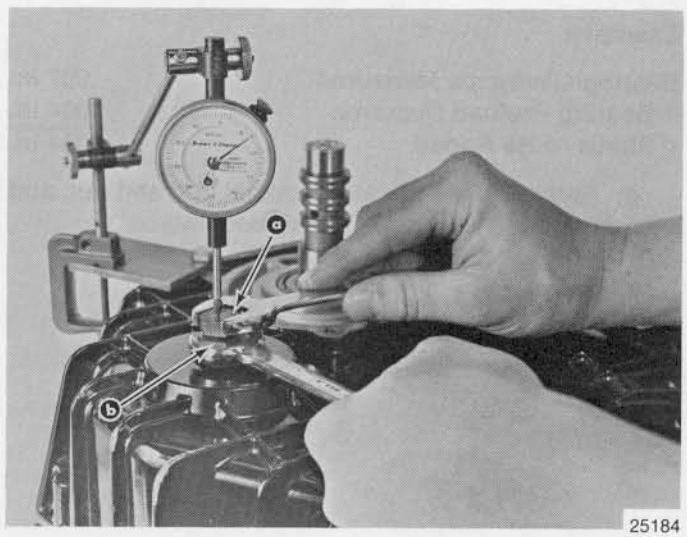
d. Zero dial indicator.



25179

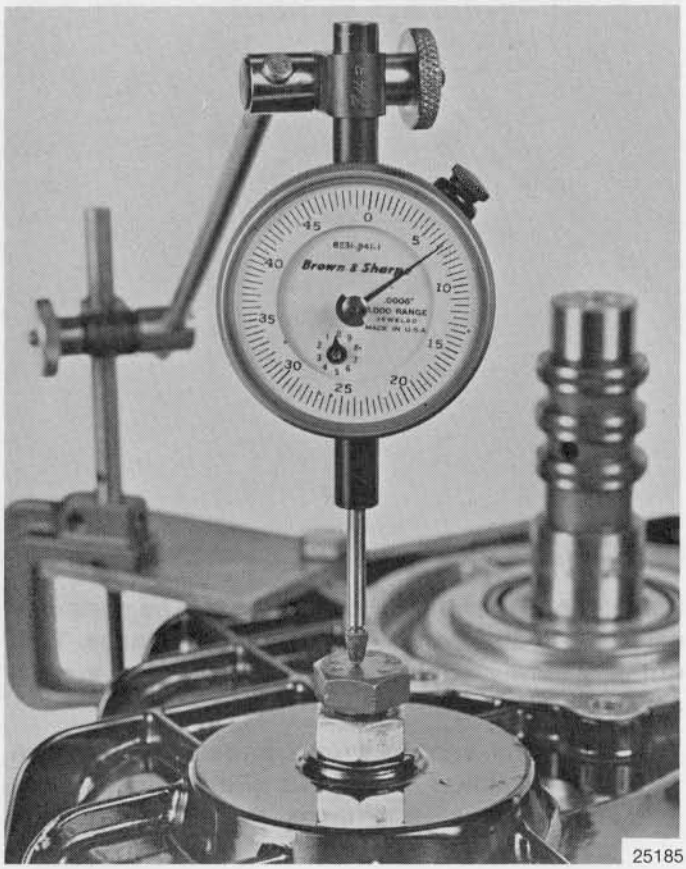
IMPORTANT: The following step should be done very carefully, to obtain the actual bearing clearance. Turn nut very slowly as shaft will only be moving a small amount.

e. Hold bolt with one wrench and slowly turn down nut to pull shaft upward. (Perform the above sequence several times to ensure accurate reading).


25184

a - Bolt - Hold Stationary
b - Nut - Turn to Move Shaft

f. Make note of the reading. The bearing clearance measured **PLUS** the preload required is equal to the amount of shim thickness to be **ADDED.**



25185

Example:

Bearing Clearance Measured	.007 in.
+ Bearing Preload Required	.004 in.
= Shims to Be Added	.011 in.

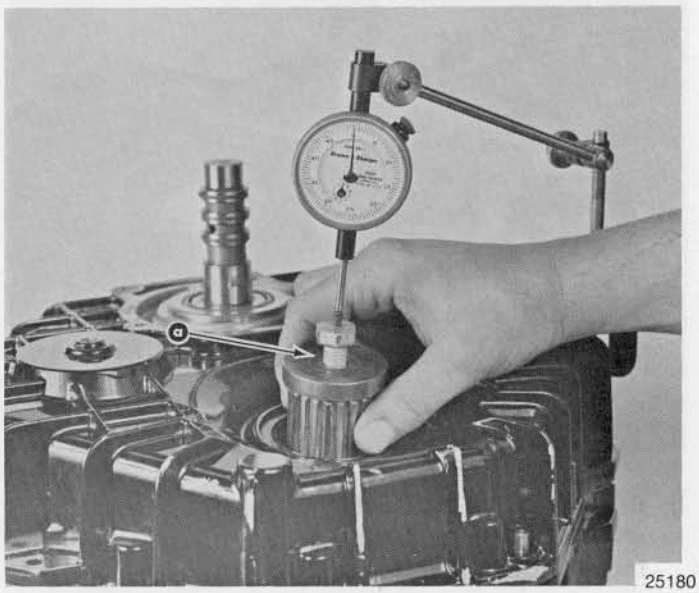
g. Remove dial indicator, special bolt and nut, and reinstall hex plug. Tighten securely.

OUTPUT SHAFT PRELOAD

37. Measure the bearing clearance as follows:

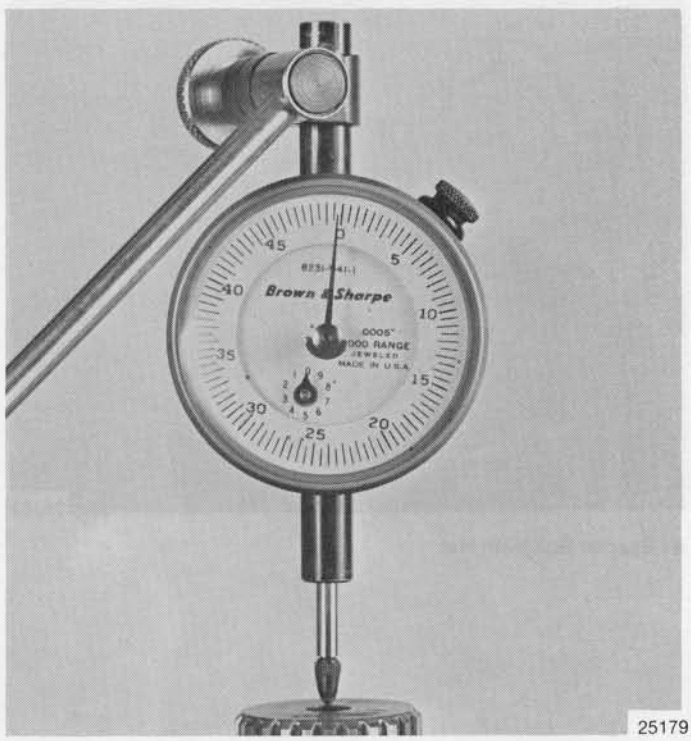
a. Install flange washer and bolt. Tighten snuggly.

b. Mount dial indicator on bolt head. Turn output shaft several times to ensure bearing is seated.


25180

a - Flange Washer and Bolt

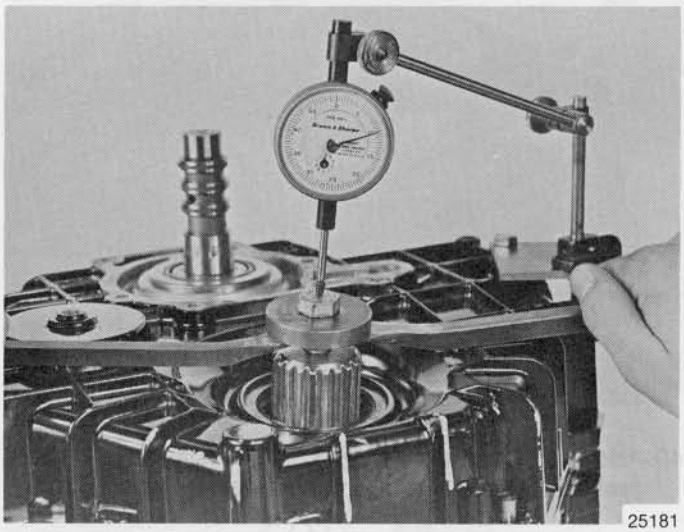
c. Zero dial indicator.



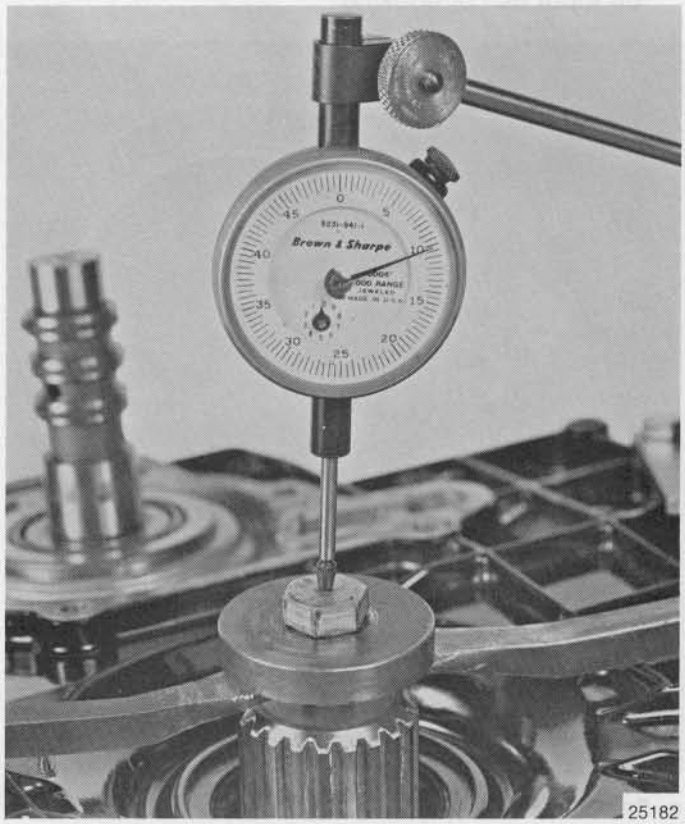
25179

IMPORTANT: The following step should be done very carefully to obtain the actual bearing clearance. Pry up gently and evenly to lift shaft. Shaft will only move a small amount.

d. Pry up on washer to lift ouput shaft.


25181

e. Make note of the reading. The bearing clearance measured **PLUS** the preload required is equal to the amount of shim thickness to be **ADDED**.



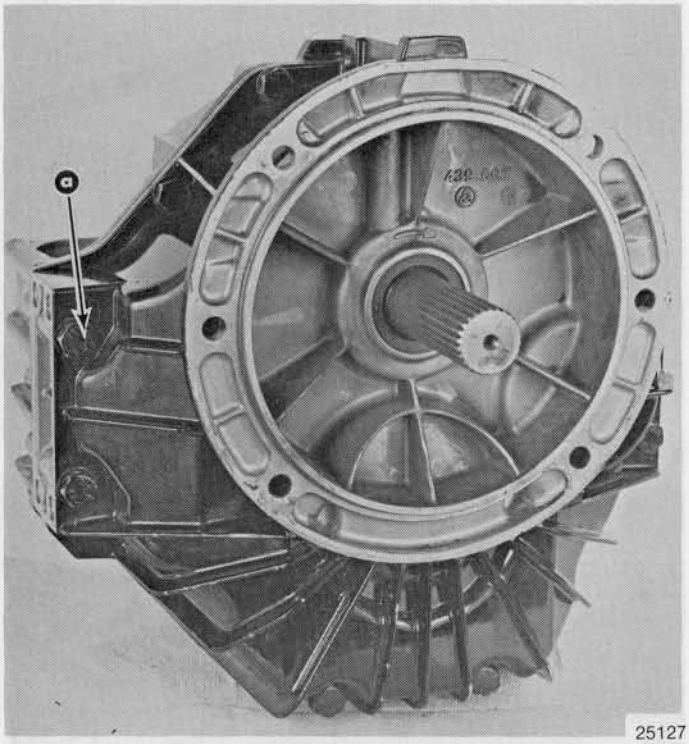
25182

Example:

Bearing Clearance Measured	.010 in.
+ Bearing Preload Required	.004 in.
= Shims to Be Added	.014 in.

f. Remove dial indicator. Remove bolt and flange washer.

38. When thickness of shims to be ADDED has been determined, the input half of housing must again be removed. Remove bolts and lockwashers, then lift off input half of housing.

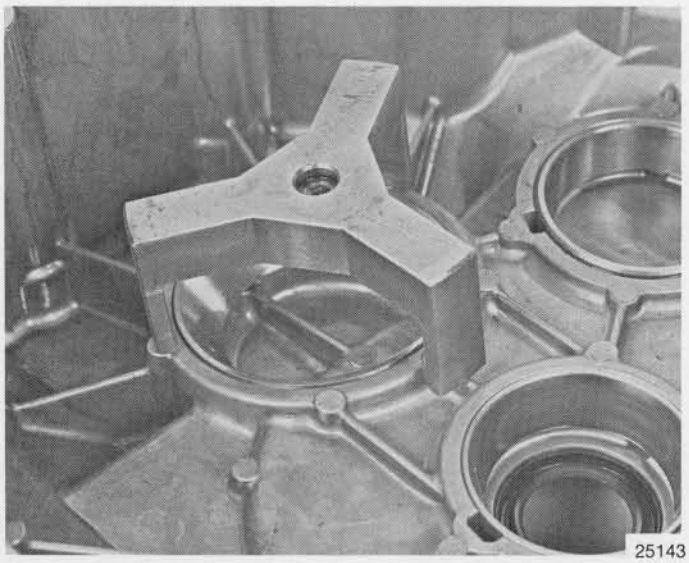


25127

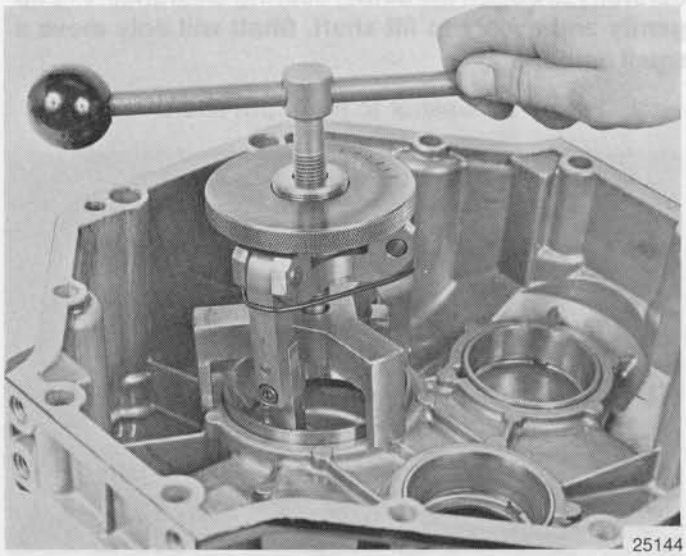
a - Bolts

39. Remove tapered roller bearing cups from housing using special puller as follows:

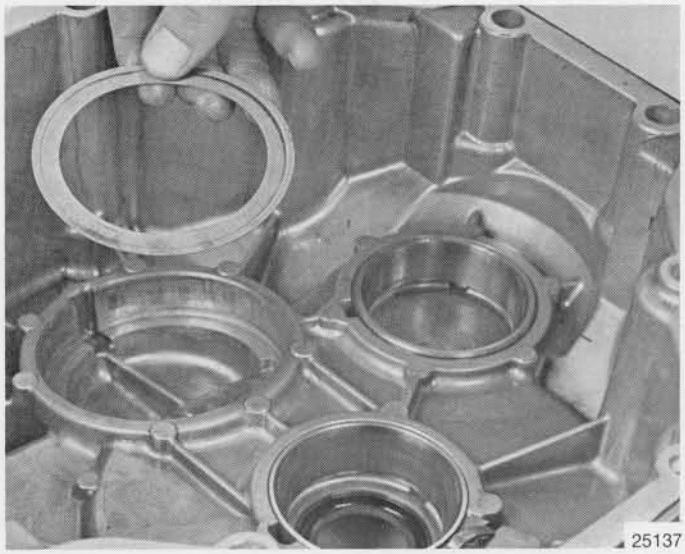
a. Position appropriate puller guide (large or small diameter) over cup as shown.


25143

b. Pull bearing cup from housing as shown.

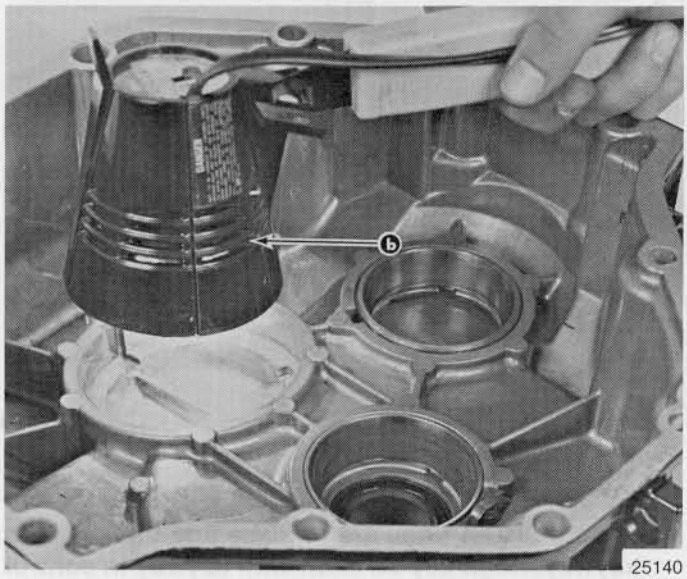

25144

40. Add the necessary amount of shims as determined previously to the appropriate bearing bores.


25137

⚠WARNING
Use care in handling housing once it has been heated with a torch lamp. Severe burns could result. Use special protective gloves when handling housing.

41. Heat each tapered roller bearing cup bore with a torch lamp. Install bearing cups into appropriate bore and tap into place using a suitable mandrel. When housing has cooled (Do not cool with water), tap bearing cups to ensure they are fully seated.



25140

Final Assembly

INPUT SHAFT SEAL

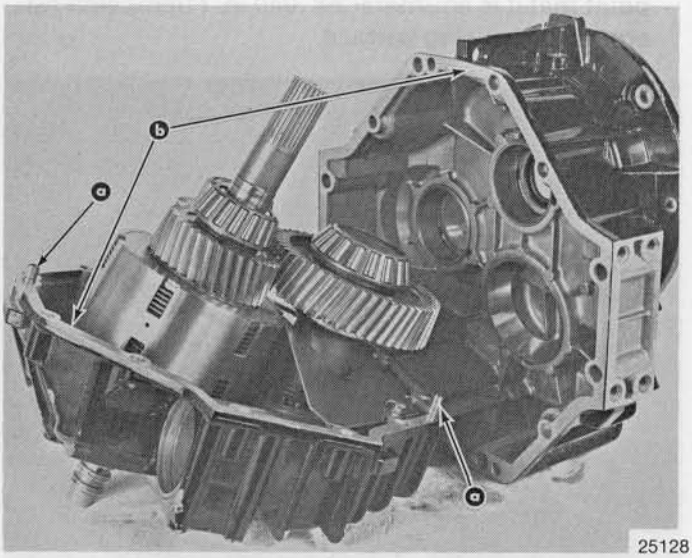
1. Push new seal onto special mandrel. Ensure seal will be positioned with lip of seal facing inward.

   Drive seal uniformly into bore of housing to the point that it is countersunk .040 in. (1mm) with reference to housing surface.

25139

a - Seals

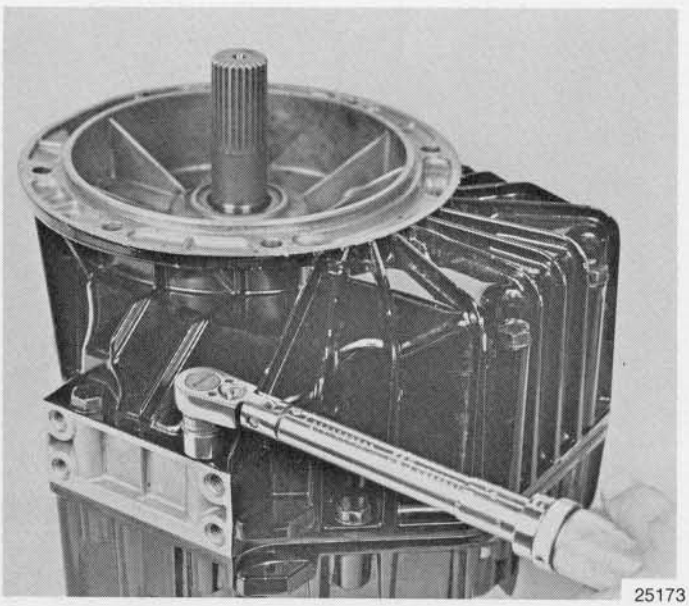
2. Coat lips of seals on input and output shafts with ATF.
3. Apply a thin layer of Loctite 515 Sealer to machined surfaces on housing halves. Reinstall input half of housing. Ensure locator pins are properly positioned.



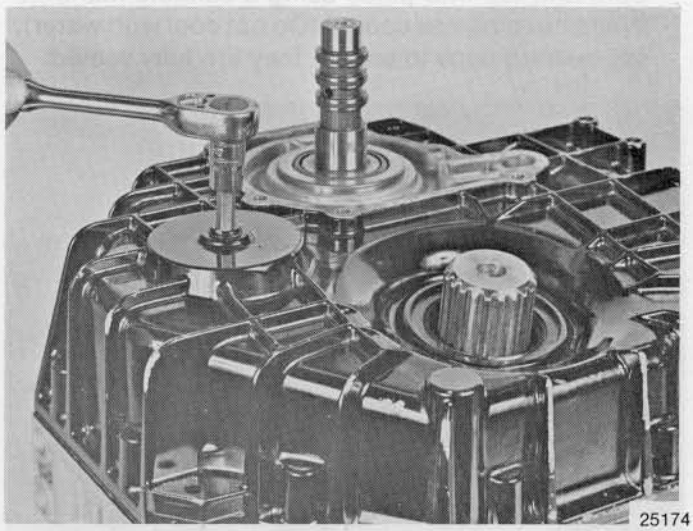
25128

a - Locator Pins
b - Machined Surface

4. Install bolts and lockwashers and torque to 36 lb. ft. (49 N.m).

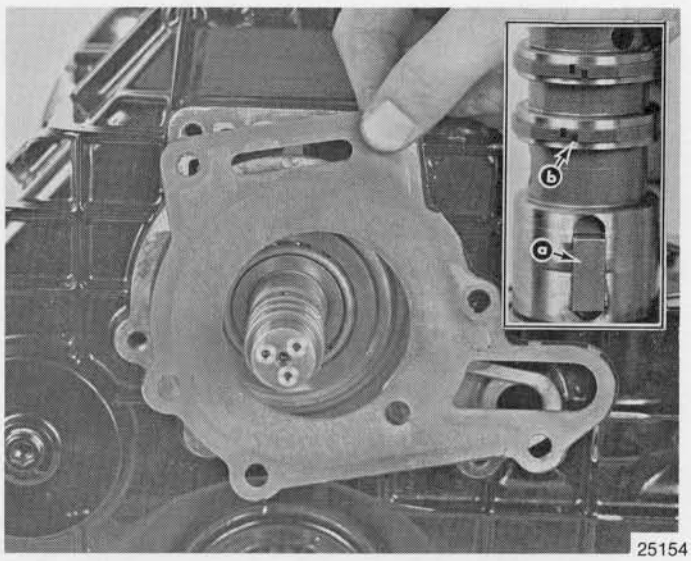

25173

5. Double check to ensure that there is no shaft clearance on all three shafts. Refer back to previous steps if necessary, and use dial indicator.
6. Remove intermediate shaft hex plug. Apply a drop of Loctite Type "A" to threads and reinstall in housing. Tighten securely.


25174

CONTROL BLOCK

7. Ensure piston rings are in place and the key is in keyway. Align key on shaft with keyway in control block.
8. Install new gasket between control block and housing.

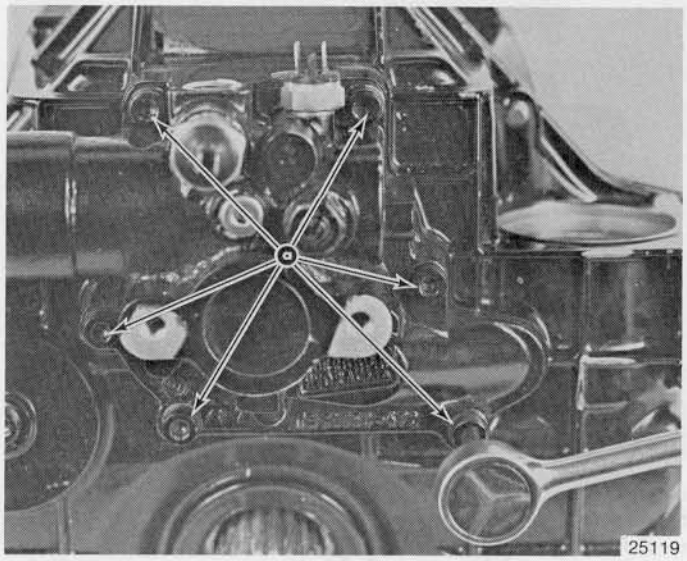


25154

a - Key
b - Piston Rings

9. Carefully push control block onto input shaft.

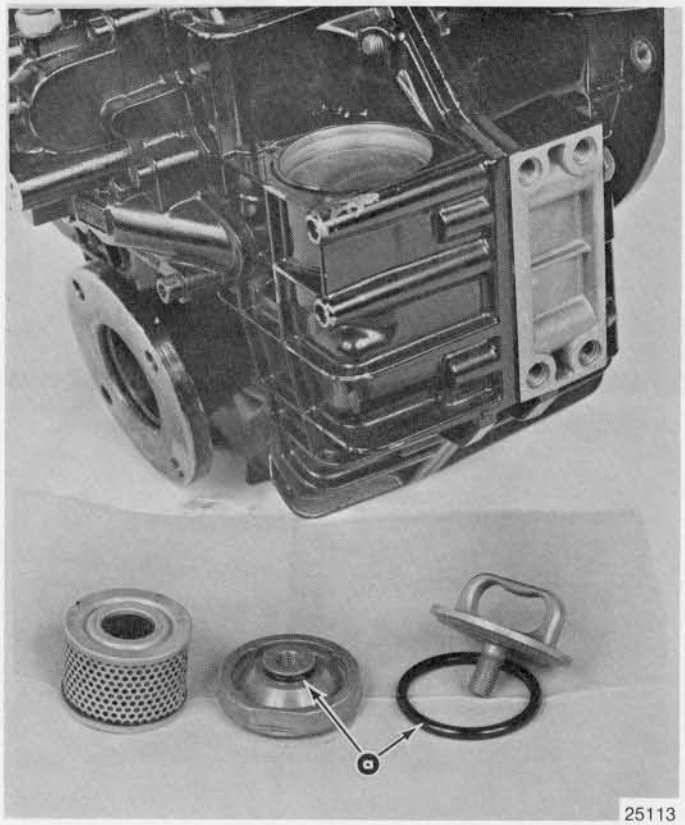
10. Coat each hex socket head bolt with a drop of Loctite Type "A". Secure control block to housing with bolts and lockwashers. Torque to 18 lb. ft. (25 N.m).



a - Hex Socket Head Bolts (6)

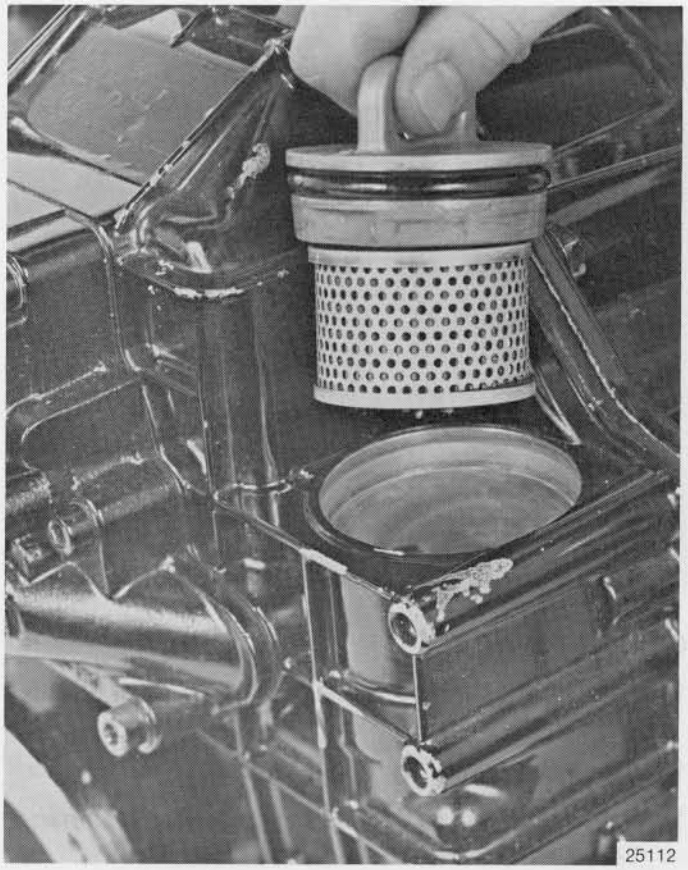
FLUID FILTER

11. Coat new o-rings with ATF.



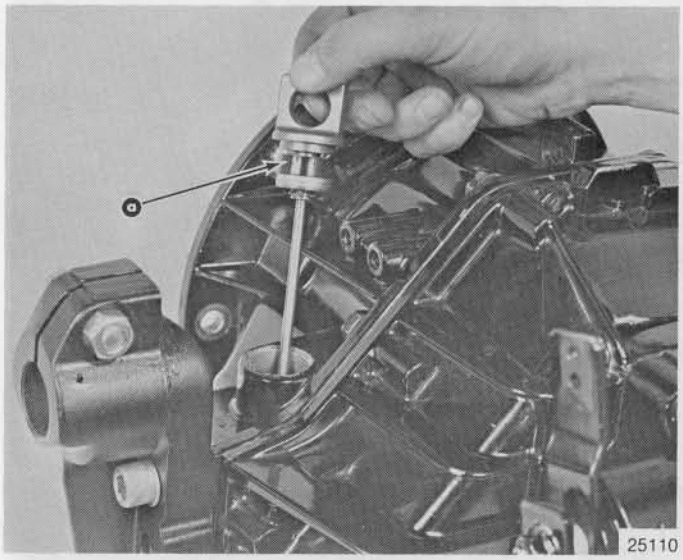
a - O-Rings

12. Reassemble filter assembly as shown. DO NOT tighten and compress upper o-ring.



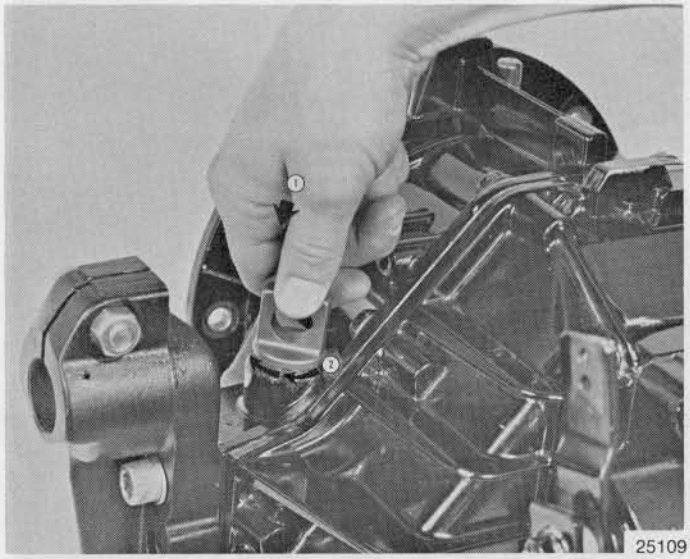
DIPSTICK

13. Coat sealing ring on dipstick with ATF.



a - Sealing Ring

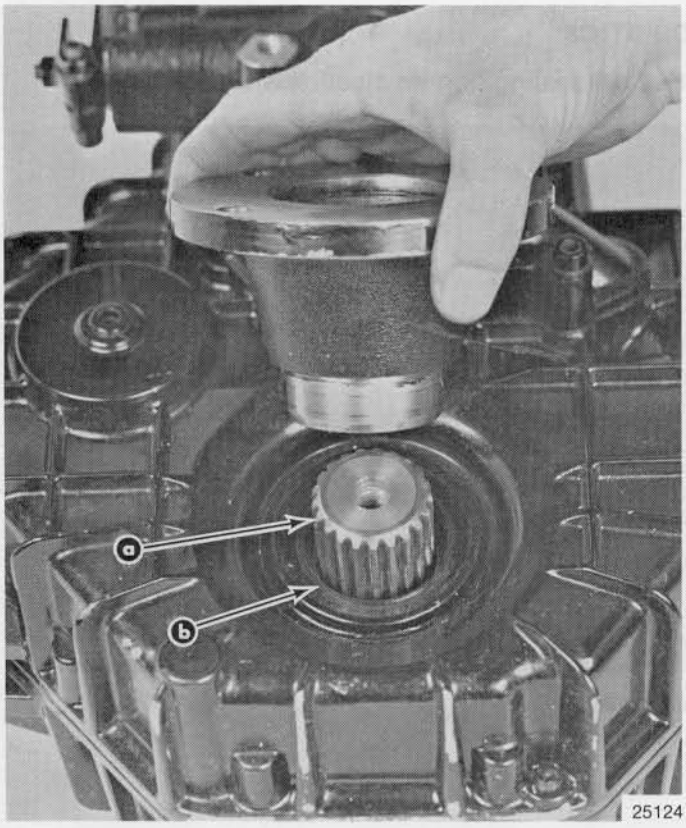
14. Install dipstick into transmission and tighten by pressing down and turning clockwise at the same time.



25109

OUTPUT FLANGE

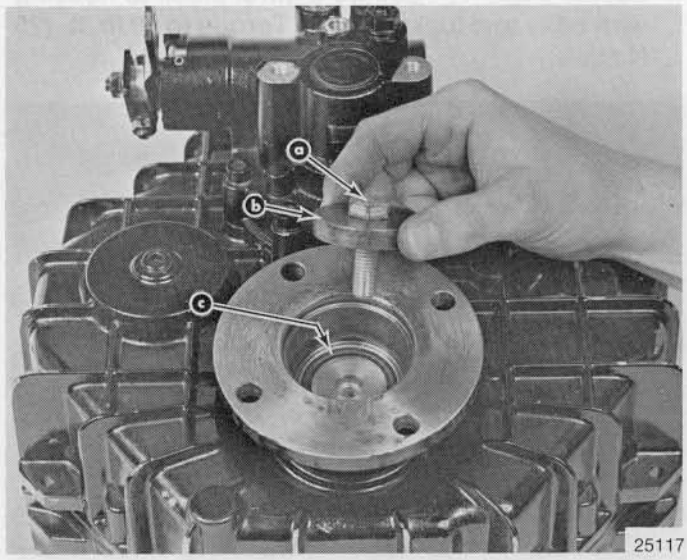
15. Coat output shaft splines with a thin coat of Loctite type "A".
16. Coat lip of output shaft seal with ATF.
17. Install output shaft flange. Be careful not to damage output shaft seal.



25124

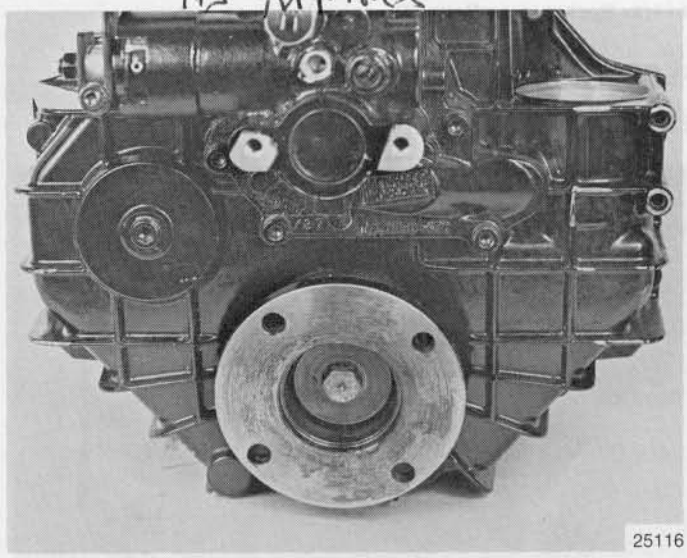
a - Splines
b - Output Shaft Seal

18. Install o-ring into flange and coat with ATF.
19. Install washer and bolt. Torque to 63 lb. ft. (85 N.m).



25117

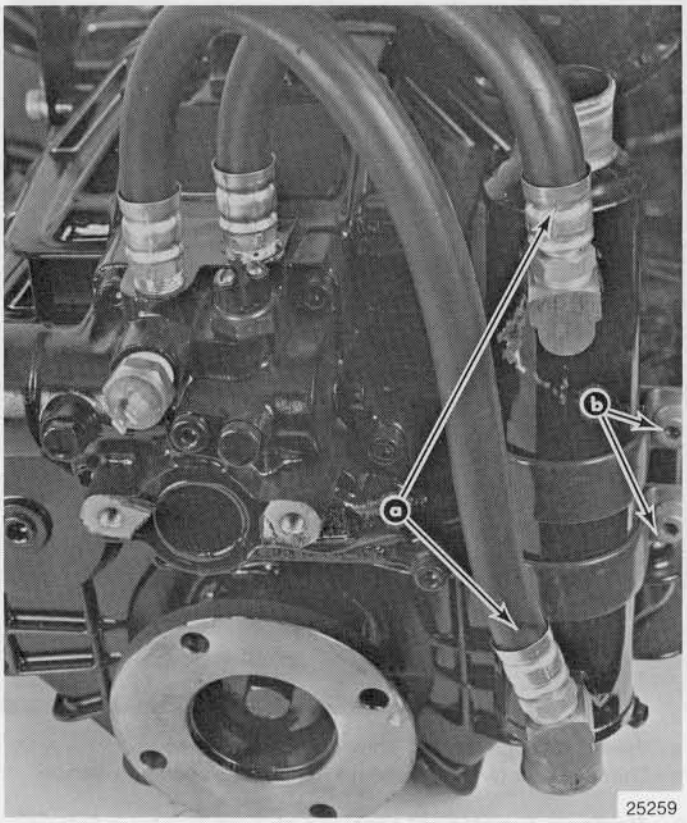
a - Bolt
b - Washer
c - O-Ring — Make sure its in place


25116

TRANSMISSION FLUID COOLER

20. Install transmission fluid cooler on housing. Secure with clamps and screws as shown. Torque to 18 lb. ft. (25 N.m).

21. Connect transmission fluid hoses to cooler as shown. Tighten securely.



a - Transmission Fluid Hoses
b - Clamps

FILLING WITH TRANSMISSION FLUID

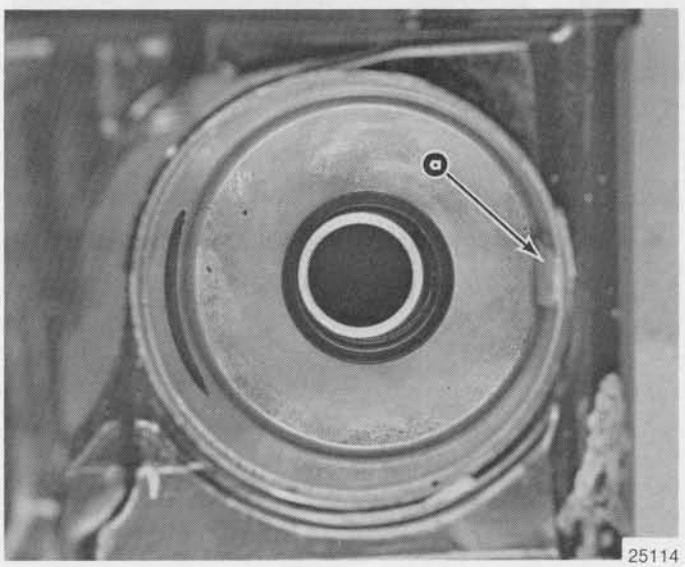
IMPORTANT: Use only ATF (Automatic Transmission Fluid), such as, Dexron II-D, or Mobile 423.

20. Fill transmission to proper level, thru oil filter cavity. (Refer to specifications for capacity).

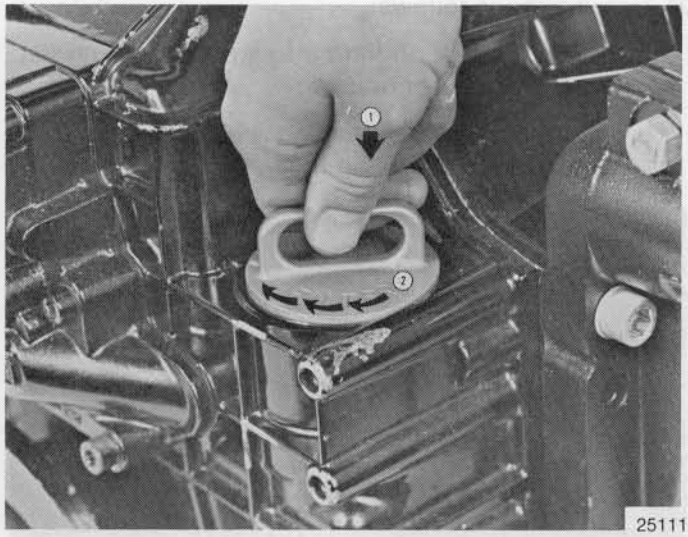
21. Install filter as follows:

    a. Bring flat spot on filter into agreement with flat surface inside of housing.

    b. Tighten filter by pushing down and turning clockwise at the same time.

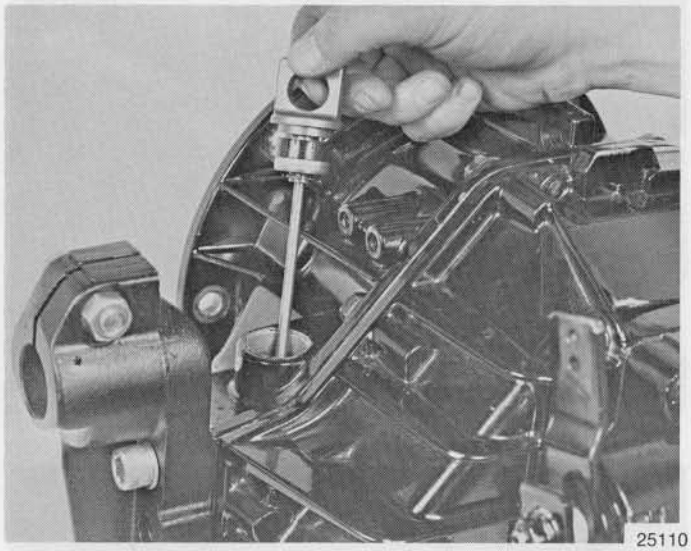


a - Flat Spot



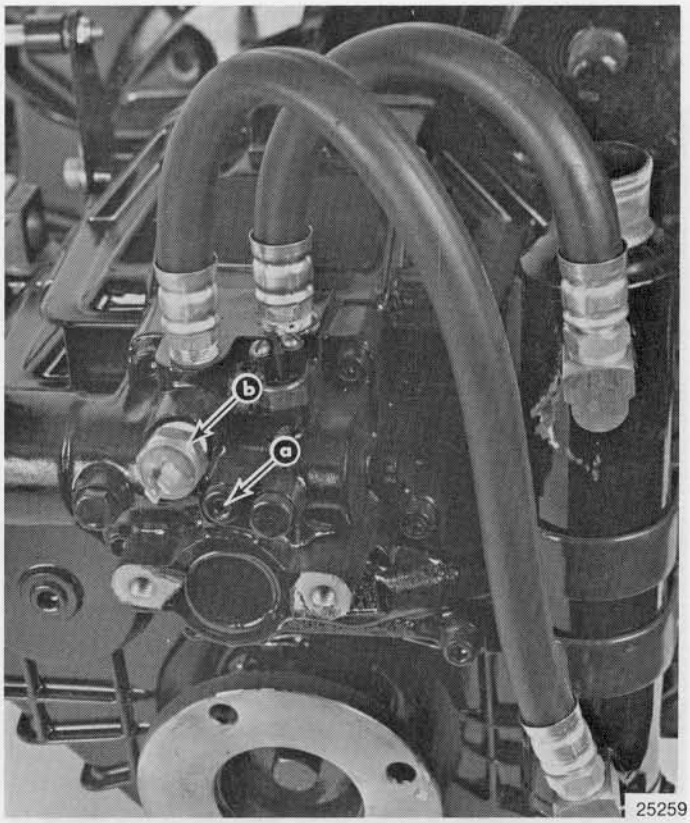
25111

22. Check fluid level. Fluid should be between "Min." and Max." marks on dipstick.


25110

Functional Test

1. Connect a pressure gauge and thermometer to fluid pump at locations shown.



25259

a - Pressure Gauge (M10X1 Thread) - Remove Plug
b - Thermometer (3/8 in. Thread) - Remove Temperature Sender

2. Perform functional tests as shown in chart following. Refer to "Operating Specifications" for correct readings.

Tests to be carried out:

1. Leakages
2. Noise emission
3. Direction of rotation, LH/RH
4. Lube oil temperature
5. Shifting pressure

The function test should be carried out as follows:

Motor speed rpm	Shift lever position	Duration minutes	Tests
800-1000	neutral	5	1 2
600-800 (idling speed)	A ⟷ B position repeatedly	—	1 2 3
1500-2500	B position	*	1 2 4
600-800 (idling speed)	A ⟷ B position repeatedly	—	1 2 3
Idling-max. speed	A position	—	1 2 5 **
600-800	from A ⟶ B position	—	1 2
Idling-max. speed	B position	—	1 2 5 **

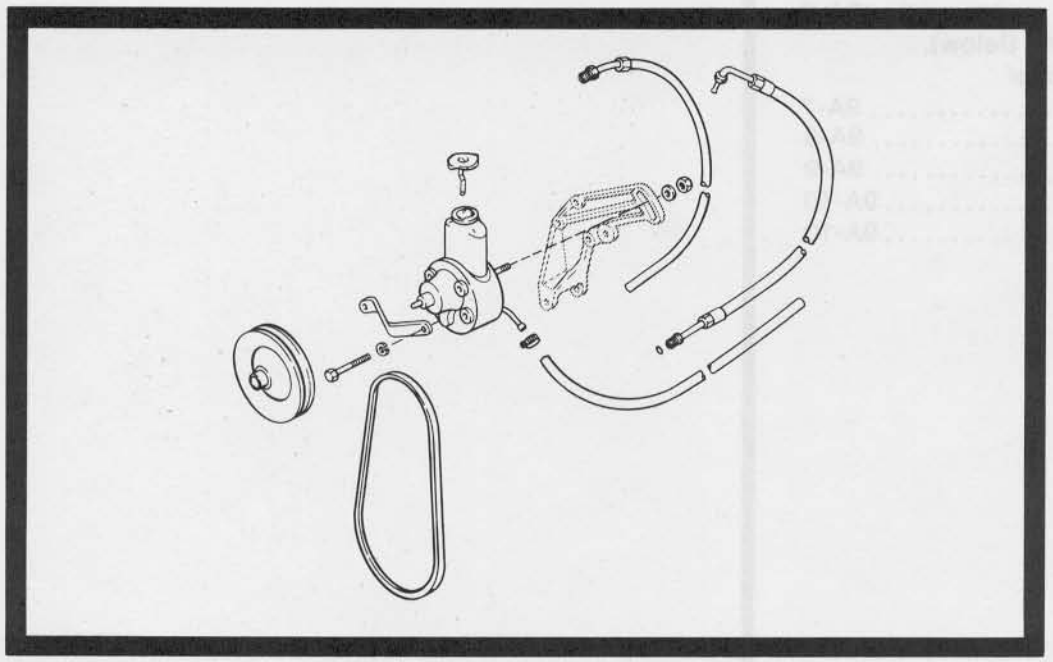
*Until an oil temperature of 75-80° C (167-176° F) has been reached

**at different speeds

POWER STEERING

9

A



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Torque Specifications

Fastener Location	305/350 CID V-8 Engines		454 CID V-8 Engines	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft (N.m)	Lbs. In. (N.m)
Crankshaft Pulley To Harmonic Balancer	35 (42)		35 (42)	
Harmonic Balancer To Crankshaft	60 (81)		80 (109)	
Pump Mounting Bracket to Engine	30 (41)		30 (41)	
Recirculation Pump Pulley		240 (27)		240 (27)

Tools/Sealants

MERCURY MARINE SPECIAL TOOLS	
91-93656A1	Pulley Installer

KENT-MOORE SPECIAL TOOLS Can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500	
J-25034	Pulley Removal Tool

SEALANTS	
92-34227	Quicksilver Perfect Seal

Precautions

⚠WARNING
Be careful when working on fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure battery is disconnected. Do not smoke or allow sources of spark or flame in the area while servicing. Wipe up any spilled fuel immediately.

⚠CAUTION
Do not operate engine without cooling water being supplied to water pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠WARNING
Always disconnect battery cables from battery before working on engine to prevent fire or explosion.

⚠WARNING
Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION
Do not pry on power steering pump or alternator when adjusting belt tension. Serious damage may result.

Checking Power Steering Pump Fluid Level

Refer to "Section 1, Part B" (see "Index").

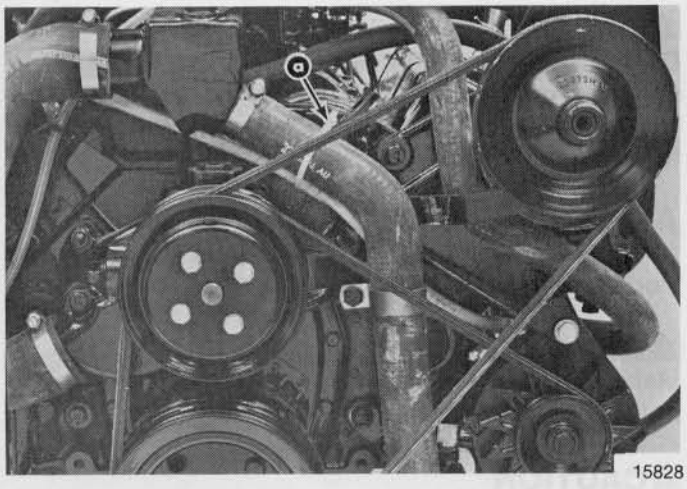
Filling and Air Bleeding Power Steering System

Refer to "Section 1, Part B" (see "Index").

Power Steering Pump Drive Belt Adjustment

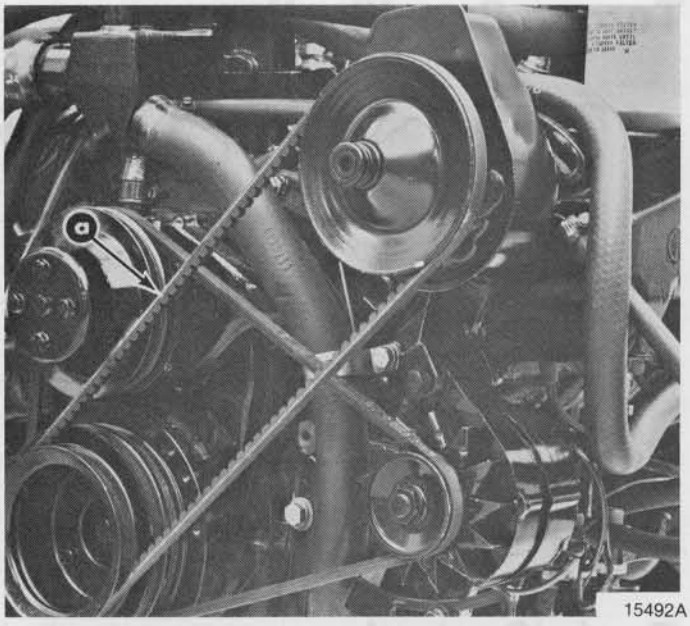
IMPORTANT: Do not pry on pump with pry bar on screwdriver.

1. Install drive belt on pulleys and adjust tension as follows:
   a. Pivot pump away from engine, as required, until correct tension is obtained, as shown.
   b. After obtaining correct tension, securely re-tighten pump brace and pump mounting bolts.
2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.



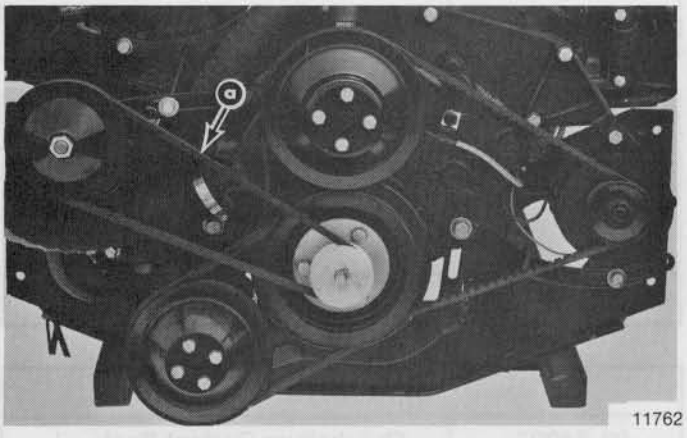
a - Belt Should Depress 1/4 In. (6mm)

MCM Models: 305 and 350 C.I.D. Engines
MIE Models: All



a - Belt Should Depress 1/2 In. (13mm)

MCM 454 C.I.D. Engines



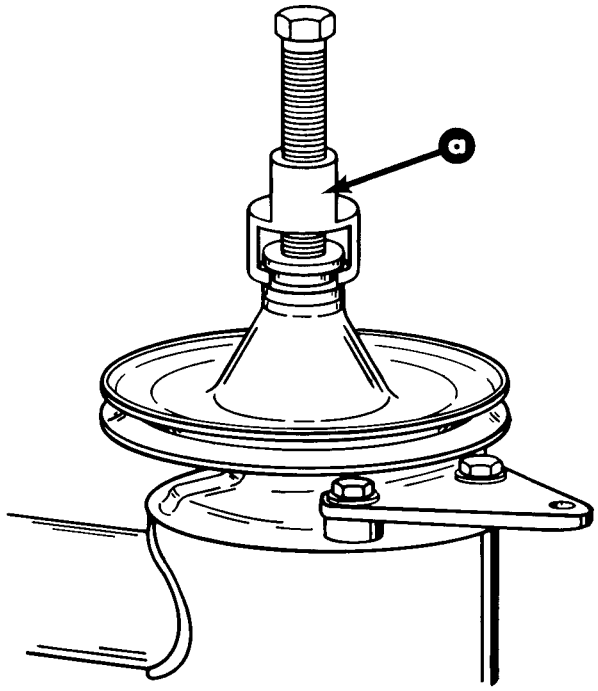
a - Belt Should Depress 1/4 In. (6mm)

MCM Production Performance Models with Auxiliary Drive Pulley

Important Service Information

Pump Pulley Replacement

IMPORTANT: Kent-Moore Tool (J-25034) must be used to remove the pressed on pulleys used on power steering pumps. This tool has an end on it that will not mushroom the end of the pump shaft. Do not use Kent-Moore Tool (J-21239) to remove these pulleys. This tool has a tapered end and will damage the shaft.



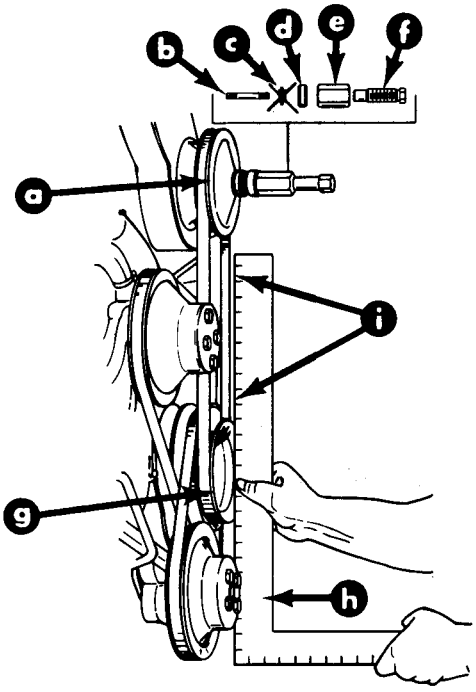
a - Kent Moore Pulley Removal Tool (J-25034 or J-21239-1)

Power Steering Pump Pulley Removal

2. Install pulley, as follows, using Pulley Pusher Assembly 91-93656A1, and a long straight edge:

   Place pulley on pump shaft.

   - Thread stud all-the-way into pump shaft. Place bearing over stud. Do not use spacer from kit.
   - Thread nut onto tool shaft. Thread tool shaft (and nut) all-the-way onto stud (threaded into pump pulley).
   - Using a long straight edge (to check drive belt alignment), turn large pusher nut until drive belt is parallel to straight edge.
   - Check pulley installation for correct alignment.



a - Power Steering Pump Pulley
b - Stud
c - Do Not Use Spacer
d - Bearing
e - Nut
f - Tool Shaft
g - Crankshaft Pulley (Shown) or Water Circulating Pump Pulley
h - Long Straight Edge
i - Drive Belt Parallel

Power Steering System Testing and Repair

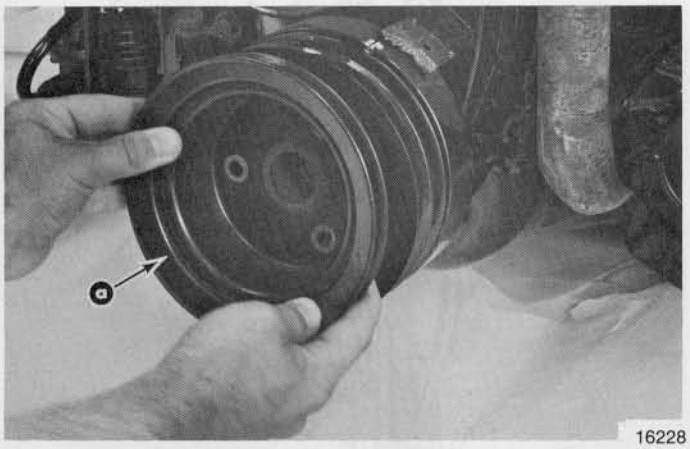
Refer to appropriate MerCruiser Stern Drive Service Manual.

Power Steering Pump Mounting and Cooler Installation

MCM 200, 230, 260, 5.0 Litre, 5.7 Litre, 7.4 Litre 330 B/W, 420, 320 EFI, 350 and 454 Magnum

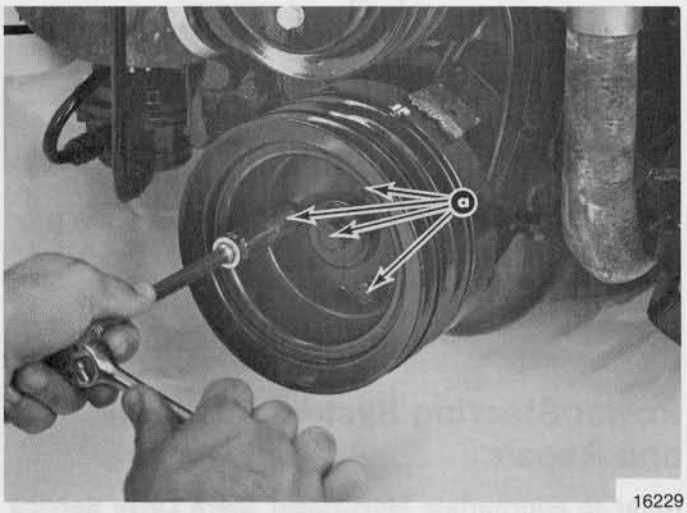
NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Install single groove pulley.



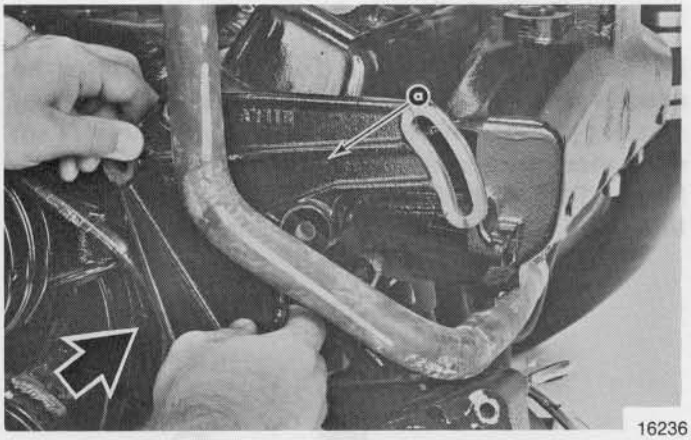
a - Pulley

2. Torque screws to 35 lbs. ft. (42 N.m)



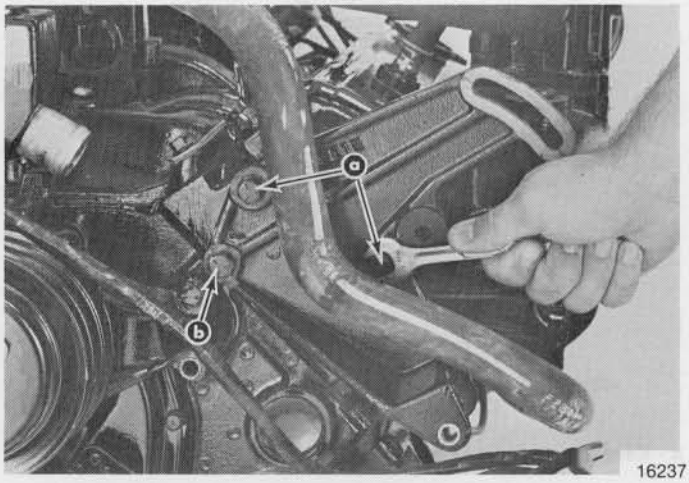
a - Screws - 3 Screws are 1 In. (25mm) Long

3. Install Power Steering pump/alternator mounting bracket.



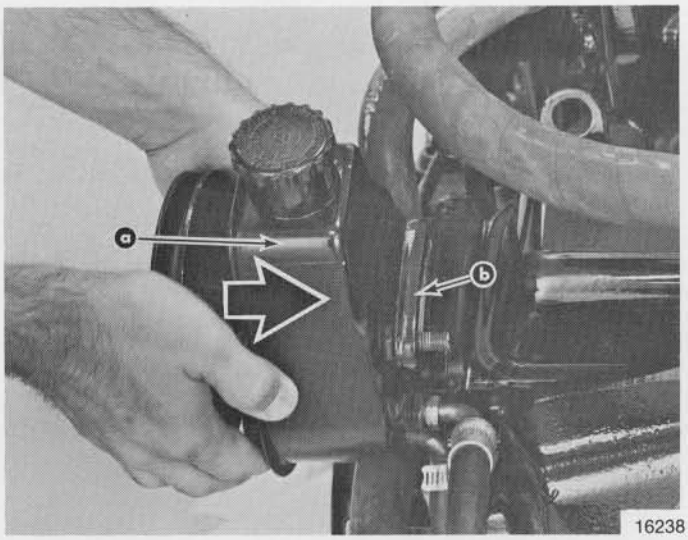
a - Bracket

4. Tighten screws securely.



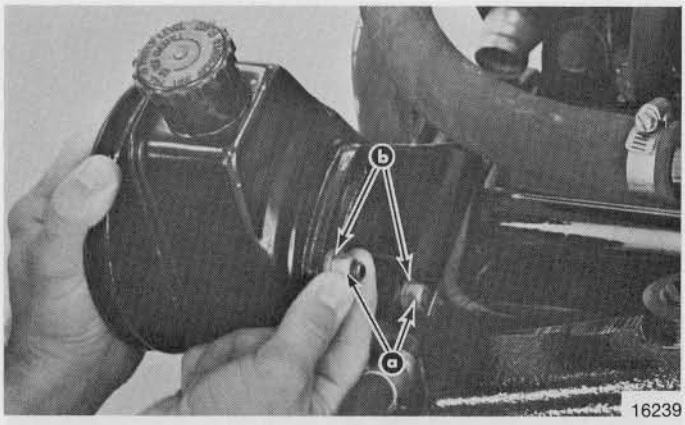
a - Install 2 1-1/4 In. (32mm) Long Bolts and Lockwashers
b - Do Not Install at This Time

5. Position Power Steering pump as shown.



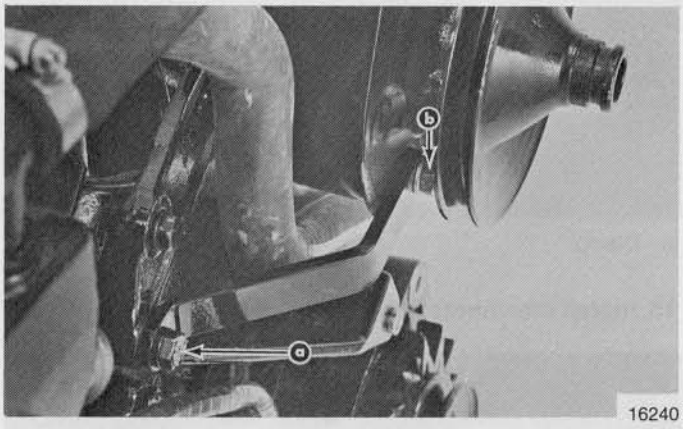
a - Pump
b - Bracket

6. Secure pump. Tighten nuts securely.



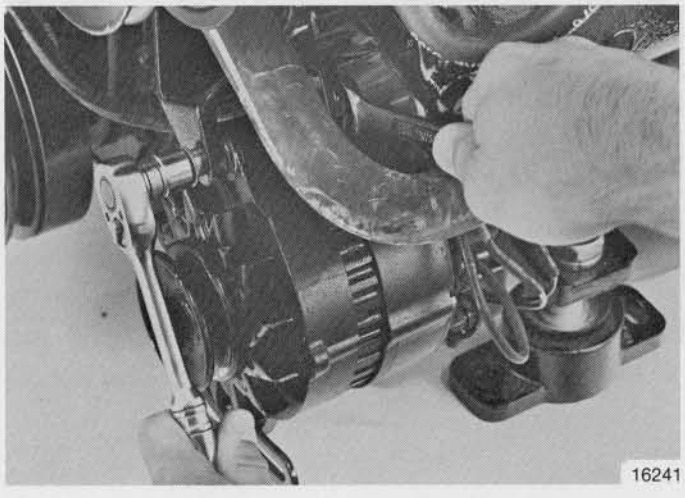
a - 15mm Nuts
b - Washers

7. Attach Power Steering pump brace.



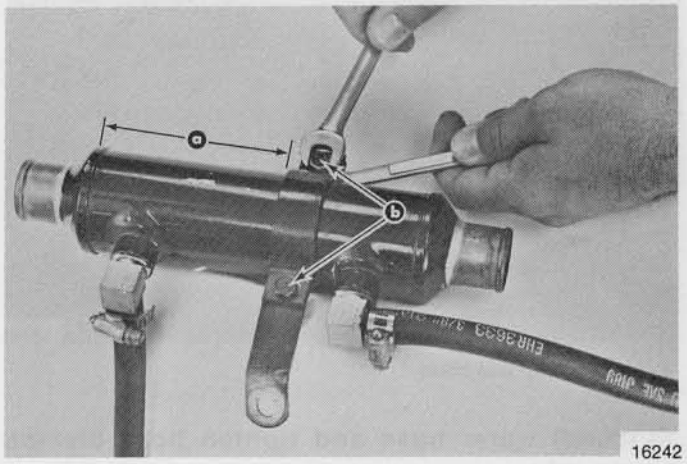
a - 1-1/2 In. (38mm) Long Bolt and Lockwasher
b - Metric Bolt (Blue) and Lockwasher

8. Attach alternator bracket.



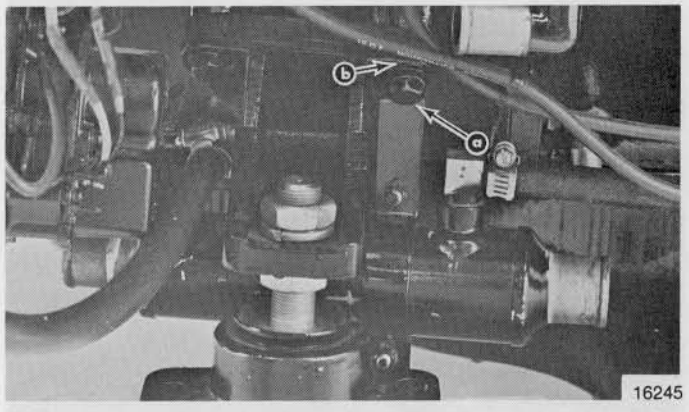
9. NOTE: Photographs in Steps 9 thru 12 show the fluid cooler for the MCM 305/350 CID engines. The cooler used on the MCM 330 B/W, 7.4 Litre may differ slightly from pictures shown.

Install fluid cooler mounting bracket.



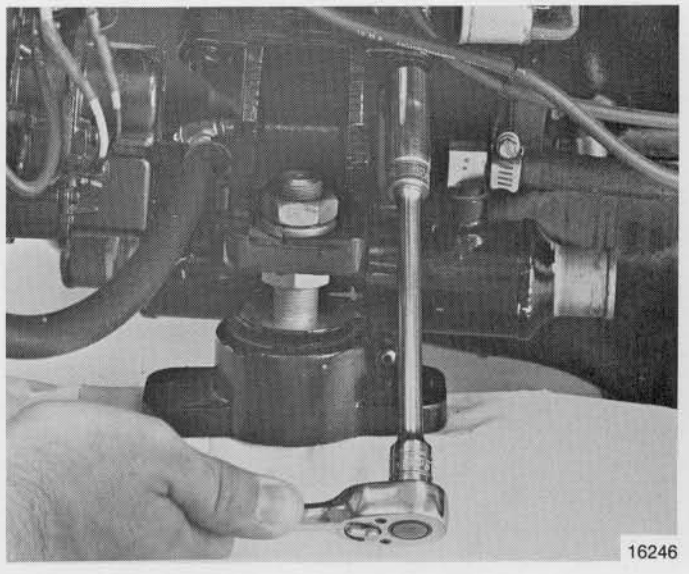
a - 4-1/8 In. (104mm)
b - 2-3/4 In. (19mm) Long Bolts and Nuts

10. Position fluid cooler as shown.

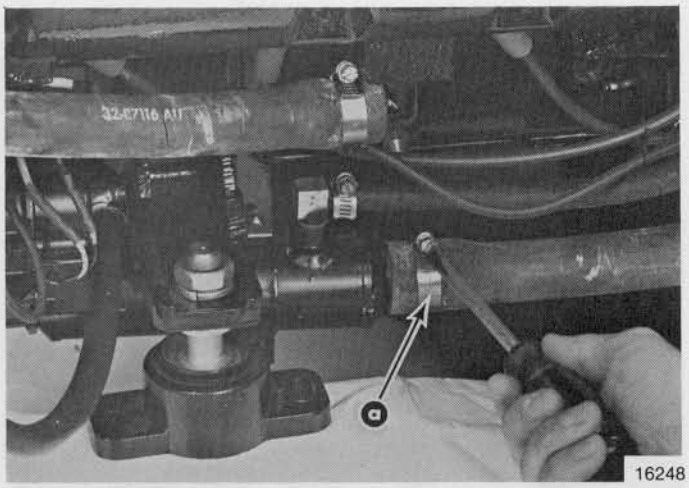


a - 1-3/8 In. (35mm) Bolt
b - Flat Washer

11. Secure fluid cooler. Tighten bolt securely.

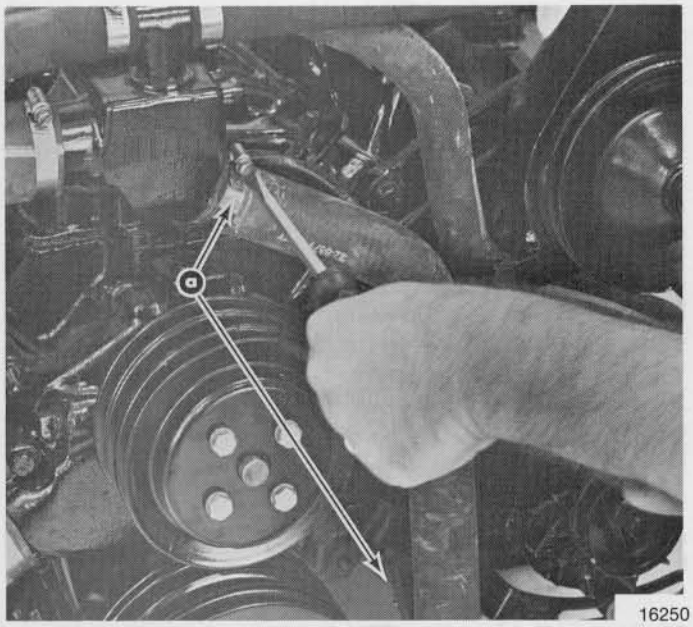


12. Install water hose and tighten hose clamp securely.



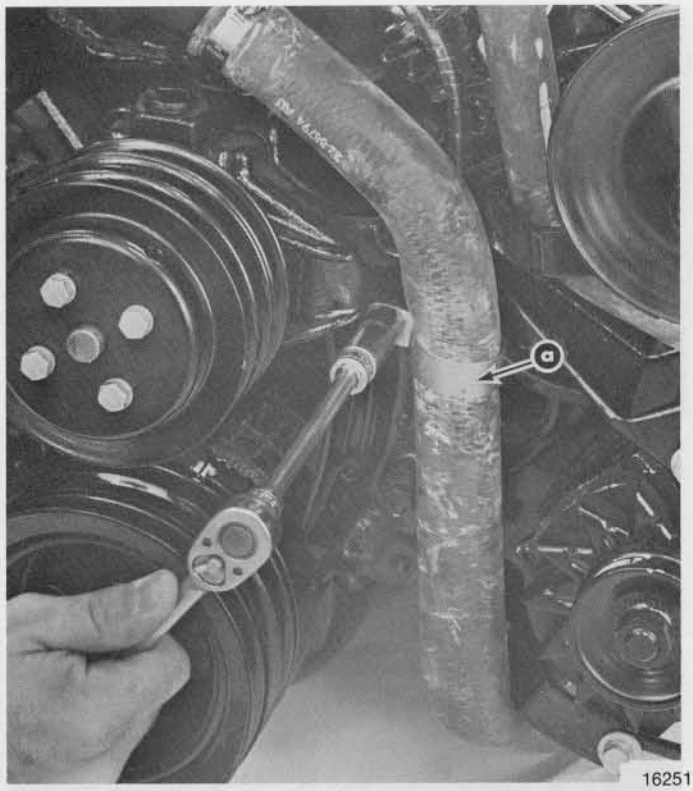
a - Hose Clamp and Hose

13. Install water hose and tighten hose clamps securely.



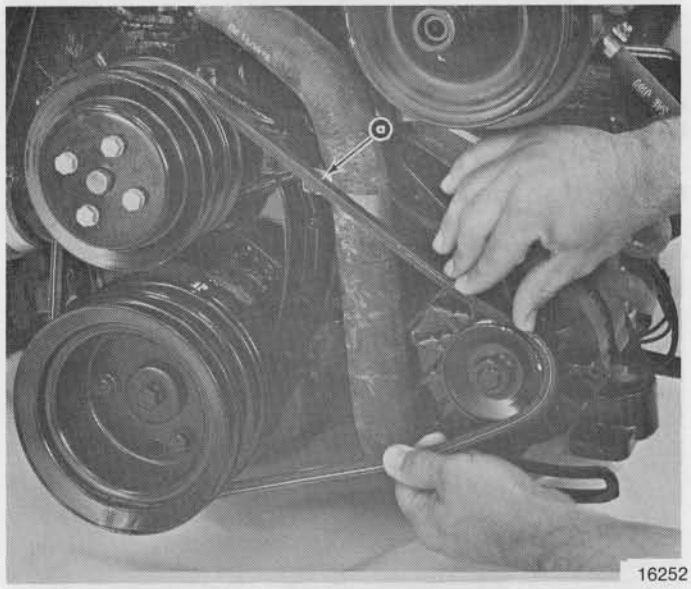
a - Hose Clamps (Lower Clamp Hidden)

14. Secure hose to circulating pump.



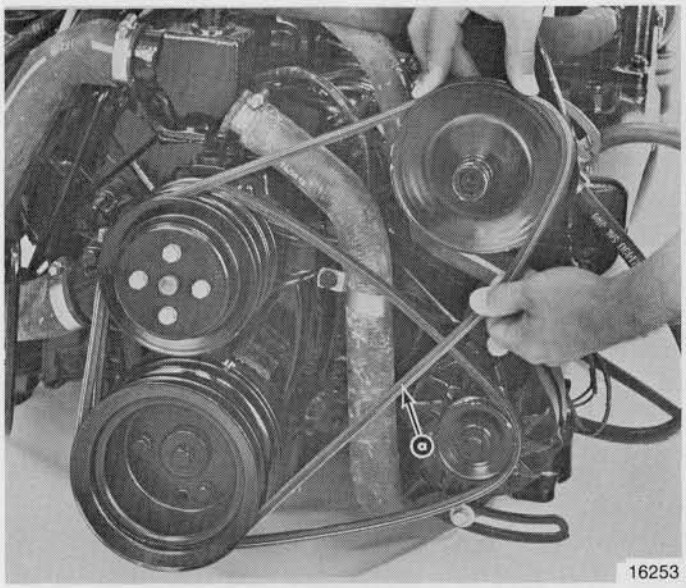
a - Clamp

15. Install alternator drive belt.



a - Alternator Drive Belt

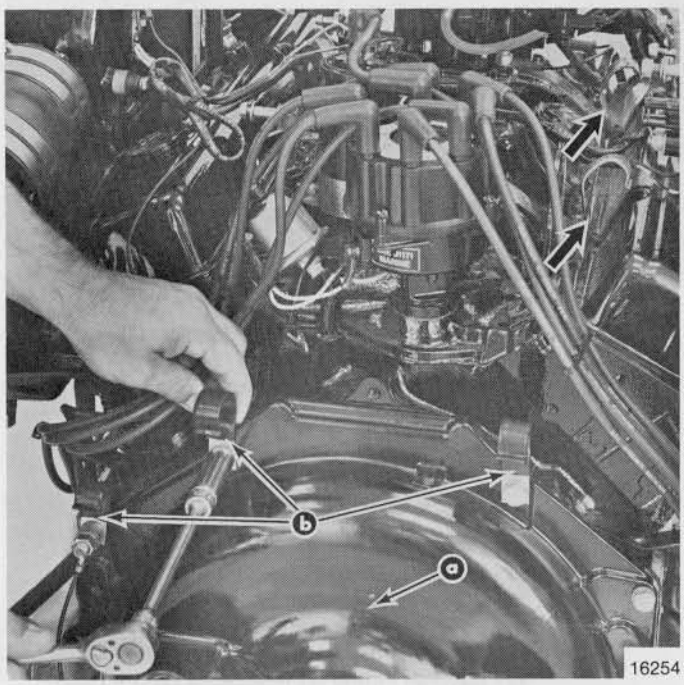
16. Install Power Steering pump drive belt.



a - Power Steering Pump Drive Belt

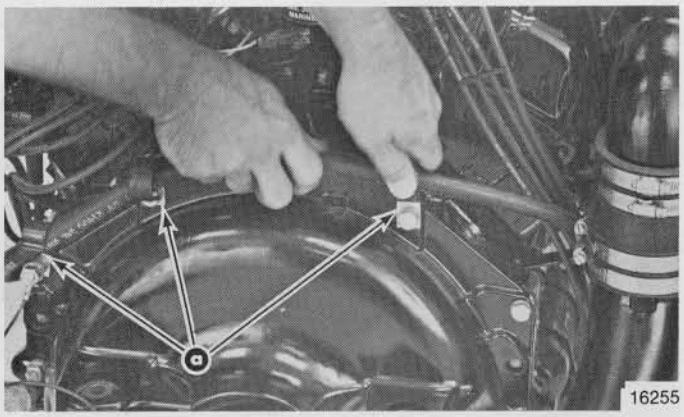
17. Adjust alternator drive belt. (Refer to Section 4, Part C). Adjust Power Steering pump drive belt as outlined in this section (see "Index").

18. Install J-clamps.



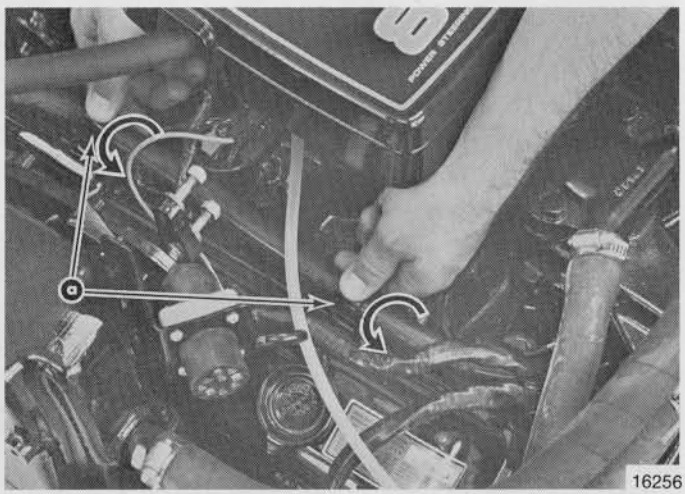
a - Flywheel Housing
b - J-Clamps

19. Route and secure low pressure hose, as shown.



a - J-Clamps

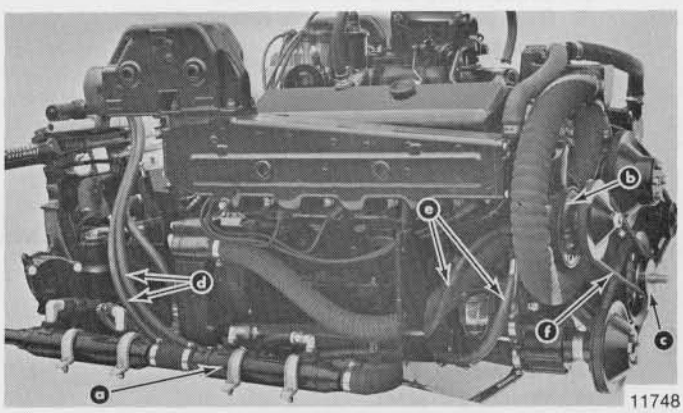
20. Route and secure high pressure hose, as shown.



a - J-Clamps

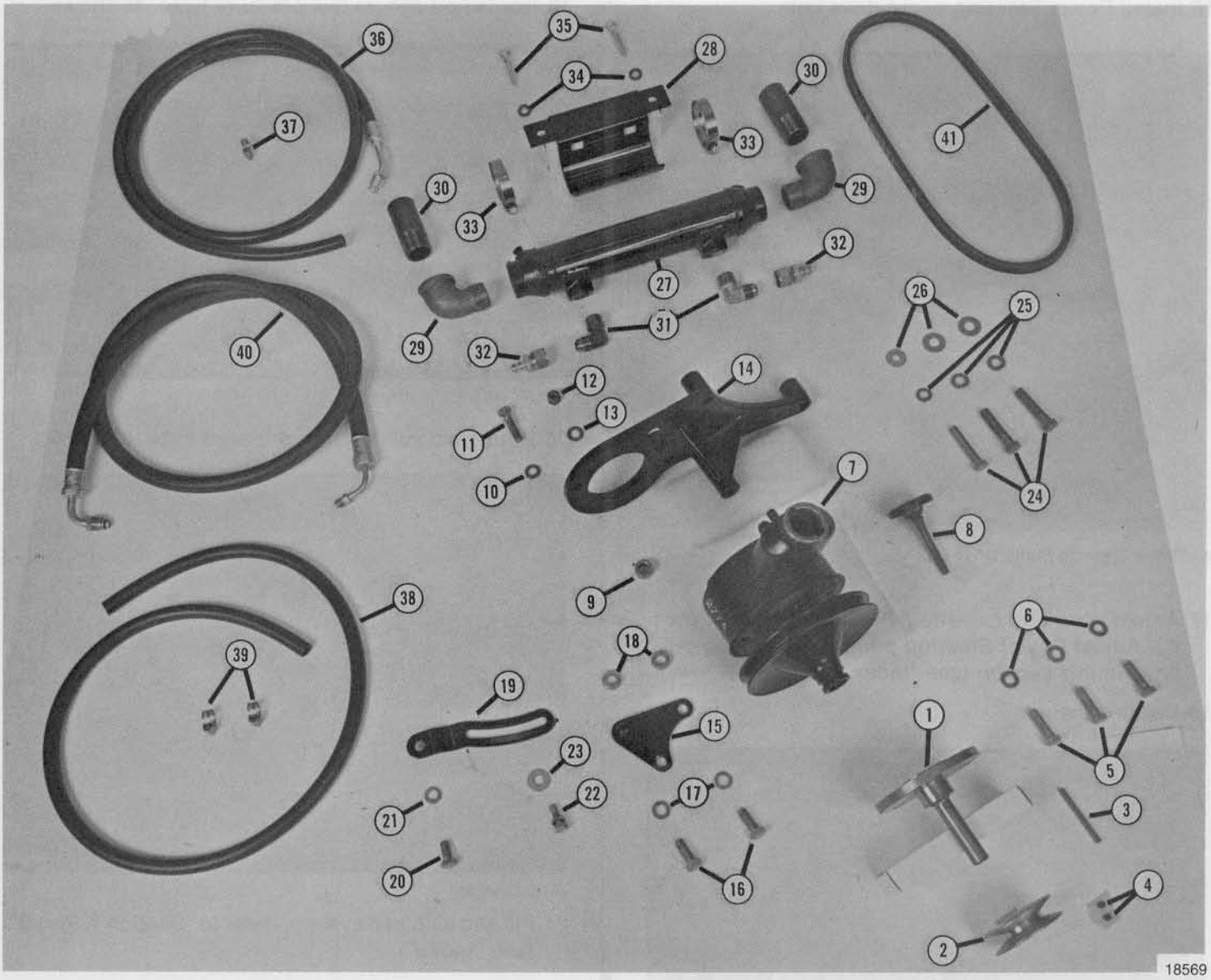
21. Fill and air bleed system. Refer to "Section 1, Part B" (see "Index").

MCM 370TRS (S.N. 6721527 and Below), 400TRS, 400/440/460 Cyclone MCM 575



a - Power Steering Fluid Cooler (Mounts on Boat Stringer)
b - Power Steering Pump (Starboard Mounted)
c - Power Steering Drive Puller
d - Hydraulic Hoses — Shows Proper Routing
e - Hydraulic Hoses — Shows Proper Routing
f - Power Steering Drive Belt

Power Steering Component Location



DRIVE PULLEY ASSEMBLY

1 - Adaptor
2 - Pulley
3 - Key
4 - Set Screws (Pulley to Adaptor) (2)
5 - Bolts (Adaptor to Harmonic Balancer) (3)
6 - Lockwashers (3)

POWER STEERING PUMP and MOUNTING BRACKET ASSEMBLY

7 - Pump
8 - Cap and Dipstick
9 - Spacer 7/16 In. (11mm) Thick - Between Pump and Mounting Bracket
10 - Lockwasher (1)
11 - Bolt (Pump to Mounting Bracket)
12 - Nut (Pump to Mounting Bracket)
13 - Flatwasher (1)
14 - Mounting Bracket
15 - Adjustment Bracket
16 - Bolts (Bracket to Pump) (2)
17 - Lockwashers (2)
18 - Spacers 1/4 In. (6mm) Thick - Between Bracket and Pump (2)
19 - Adjustment Brace
20 - Bolt (Brace to Bracket)
21 - Lockwasher (1)
22 - Bolt (Brace to Mounting Bracket) (1)
23 - Flatwasher (1)
24 - Bolt (Mounting Bracket to Engine) (3)
25 - Lockwashers (3)
26 - Flatwasher (3)

COOLER ASSEMBLY

27 - Cooler
28 - Mounting Bracket
29 - Elbow (2) (Seawater Hose)
30 - Bayonet (2) (Seawater Hose)
31 - Elbow (2) (Hydraulic Return Hose)
32 - Bayonet Fitting (2) (Hydraulic Return Hose)
33 - Clamps (Cooler to Bracket)
34 - Lockwashers (2)
35 - Lag Screws (2) (Bracket to Stringer)

MISCELLANEOUS

36 - Return Hose (Transom Plate to Cooler)
37 - Clamp (1)
38 - Return Hose (Cooler to Pump)
39 - Clamps (2)
40 - Pressure Hose (Pump to Transom Plate)
41 - Drive Belt

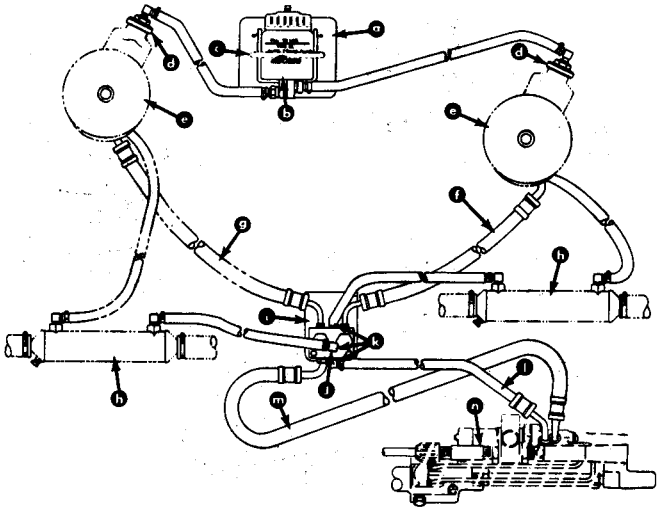
Engine Power Steering Components - Exploded Parts View

Priority Valve Kit (79691A1)

IMPORTANT: This kit is for use on dual installations where both engines are equipped with Power Steering pumps, coolers, related hardware and hoses and one transom assembly is equipped with Power Steering.

Installing Reservoir

1. Mount reservoir bracket (Figure 1) to transom with 2 screws (from kit) halfway between the 2 Power Steering pumps in a location that affords both accessibility and visual inspection of reservoir oil level. Be sure that location is at least 6 in. (15.2cm) higher than pump and is far enough away from any obstruction that might prevent mounting of priority valve. Priority valve must be mounted no closer than 2 in. (51mm) from bottom of reservoir.



a - Reservoir Bracket
b - Bottle Reservoir
c - Retainer Spring
d - Cap Assemblies
e - Power Steering Pumps
f - Secondary Pressure Line
g - Primary Pressure Line
h - Coolers
i - Priority Valve Bracket
j - Priority Valve
k - 90° Elbows
l - Return Hose from Kit
m - Pressure Hose from Kit
n - Power Steering Control Valve

Figure 1. Priority Valve Kit

2. Position bottle reservoir in mounting bracket and secure with retainer spring from kit.

IMPORTANT: The two-way check valve (Figure 2) is required for cold weather operation below 40° F (4° C). Remove vent from cover and replace with two-way check valve, if conditions require. (it is not necessary to replace vent if temperature is above 40° F (4° C), unless reservoir overflows during operation).

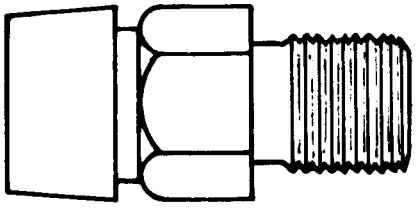


Figure 2. Two-Way Check Valve

3. From bulk hose (supplied with kit; hose without fitting), cut 2 hoses of sufficient length to extend from bottom of reservoir to fill caps on pumps. (Figure 1) Allow enough extra hose for routing and installation of cap assemblies.
4. Secure hoses with sta-straps to keep them below reservoir and away from excessive engine heat and moving parts.
5. Position hose clamps over ends of hoses, connect one end of each hose to reservoir and other end of each hose to a cap assembly. (Figure 1) Tighten hose clamps securely. Do not fasten caps to pumps at this time.

Installing Priority Valve

1. Install valve mounting bracket with 5/16 in. x 2 in. (51mm) lag bolts and washers (from kit) in a central position under reservoir. Be sure that location will alllow 2 in. (51mm) or more between priority valve and reservoir when priority valve is mounted to bracket.
2. Install 90° elbows (from kit) into priority valve (at locations marked "T"), using location of coolers, Power Steering control valve and Figure 1 as guides for direction of elbows. Use liquid pipe joint sealer to seal connections and tighten fittings securely.
3. Secure priority valve to bracket with 5/16 in. x 2-3/4 in. (70mm) hex head bolts, nuts and washers from kit. Tighten securely.
4. From bulk hose (supplied with kit; hose without fitting), cut 2 hoses of sufficient length to extend from Power Steering cooler to respective fitting (Figure 1) on priority valve.
5. Position hose clamps over ends of hose and connect one end of each hose to its respective Power Steering cooler and the other end of fitting on priority valve. (Figure 1) Use sta-straps to keep hose away from excessive engine heat and moving parts.
6. Install hose (fitting on one end only, from kit) to Power Steering control valve. (Figure 1) Route hose to priority valve, then cut hose to length, position hose clamp over end and install hose to its respective fitting. (Figure 1)
7. Install hose (with fittings on both ends, from kit) between Power Steering control valve and priority valve, as shown in Figure 1.
8. Install both pressure hoses (leading from pumps) to locations on priority valve, as shown in Figure 1.

Filling System with Fluid

1. Remove shipping caps from pump reservoir (if not already removed) and fill reservoirs with Automatic Transmission Fluid (ATF), Dexron, or Dexron II.
2. Install caps (from kit) on pump reservoir so that after twisting each cap 120°, the fitting (hose) is facing forward (away from engine block).
3. Fill bottle reservoir to full mark, then (one at a time) twist and remove caps (hold cap above pump reservoir). Allow fluid to flow through line into pump reservoir. When pump reservoir is close to overflowing, reinstall cap as described in Step 2. Fill bottle reservoir and repeat process for other cap.
4. Torque large nut on cap to 70 lbs. in. (8 N.m) to secure cap to pump reservoir.

⚠CAUTION

While pump is operating, do not turn steering wheel left or right until Step 5 is completed, or air will be induced into control valve.

5. With the boat in the water or cooling water hooked up, start one engine. Add any fluid required to maintain reservoir level. Should growling in pump or foaming of fluid occur, stop engine and allow fluid to settle for 5 to 10 minutes. Refill bottle reservoir and repeat procedure for other engine.
6. After the air is worked out of the system and the bottle reservoir maintains its level, check the function of the valve as follows:
   a. Start the first engine and turn steering wheel while checking for power assist.

IMPORTANT: Maintain oil level in bottle reservoir while checking valve function.

   b. Start second engine and turn steering wheel, checking for power assist.
   c. Stop engine No. 1 and turn steering wheel while checking for power assist.
   d. Start engine No. 1 and stop engine No. 2, then turn wheel and check for power assist.
7. After checking function of valve, stop engine; check all connections for tightness.